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SPEED TRIALS OF THE NEW BRITISH ROYAL YACHT VICTORIA AND ALBERT.

A series of trials of the sea going capabilities of the new British Royal yacht *Victoria and Albert* have recently been carried out by Admiralty officials. In the daily press a good deal of gush has been published as to the results of these trials, and this has been faintly echoed in some of the technical journals. According to the *London Times*, which on naval matters is usually authoritative, the "yacht has proved a capital seaboat, and has run in all her trials with admirable steadiness." We here present a reproduction of a photograph of the yacht as she was going out to sea on one of the trial trips. It will be observed that radical changes have been made in the appearance of the vessel as compared with the original construction. In place of the lofty heavy masts with which she was fitted before the "mishap" at Pembroke Dockyard, she now has short light sticks. The funnels have also been cut down, and for the original three, two only have been substituted. A great many structural changes have also been made with a view to get rid of topheaviness, and these are not apparent to the eye in the outside view.

BRITISH ROYAL YACHT VICTORIA AND ALBERT STEAMING OUT TO SEA FOR SPEED TRIAL.
Photograph Copyright 1900, by Symonds, Portsmouth.

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The new yacht is of these dimensions: Length over all, 420 ft.; between perpendiculars, 380 ft.; beam, 50 ft.; displacement, 4,700 tons in 18 ft. draft. She is fitted with twin screws driven by four cylinder triple expansion engines of 11,000 designed horse power. She was intended to be capable of maintaining a sea speed of 17 knots and of reaching 20 knots when pushed. Belleville water tube boilers were fitted. The hull was built at the Royal Pembroke Dockyard and the machinery by Humphreys & Tennant.

The steaming trials were carried out in the English Channel. There were three preliminary trials at about half and three-quarters speed each of 48 hours' duration, and a final full power trial lasting eight hours. On the second trial the following were the mean results: Revolutions, starboard, 128.2, port, 129.7; I. H. P., starboard, 3,765, port 3,884, total 7,649; speed, 18.47 knots, coal consumption, 1.87 lb. per I. H. P. When this trial was carried out there was a heavy sea with ground swell in the Channel, "but it had no effect on the yacht," says the *Times*, "which, as on the last occasion, proved a thoroughly trustworthy sea boat. There was no perceptible vibration, and in the saloon it was difficult to realize that she was under way in a heavy sea." On the full power trial the yacht made four runs over a measured course off the Cornish coast and completed the eight hours steaming by going up the Channel full speed until the expiration of the time limit. During this trial the yacht drew 18 ft. 2 in. forward and 20 ft. 1 in. aft. The steam pressure carried on the boilers was 306 lb. Revolutions were 147.2 for the starboard engine and 147.6 for the port, and the vacuum 25.2 in starboard and 25.3 in port. The I. H. P. was 5,620 for the starboard engine and 5,678 for the port, or 11,298 collective. The mean air pressure was .6 in. and the mean of the four runs gave a speed of 20.53 knots. No record of coal consumption was kept, which is not to be wondered at considering the rate at the lower speeds.

With reference to the behavior of the yacht during the trials the authority already quoted continues: "The trials have been of especial interest from the constructor's point of view, for after the unfortunate incident at Pembroke some doubts arose as to her stability in a seaway; but fortunately these doubts have been entirely dissipated by the behavior of the yacht in two gales, when her speed did not fall off to an appreciable degree, while in a moderate breeze she was perfectly steady. Whether she has had to steam through a heavy sea or through smooth water the bow wave has been clean and regular, with a fine run from the stem to the midship section, and no volumes of water of weight have been thrown off from any part. Nor has there been any churning or thumping under the quarter whether the ship has been traveling at her highest speed, or running through a gale. Each trial also disclosed an absence of vibration over the propellers, while the tests that were made in the worst weather she encountered showed that the angle of heel in rolling did not exceed eight or ten degrees. The hull and engines have thus answered all the requirements of the designers."

Private advices do not speak in such unqualified terms of praise of the new vessel, and it is generally understood she will be sent across the Atlantic to Nova Scotia to test her sea going qualities. It is not unlikely indeed that the members of the Royal household will need some special demonstration of her seaworthiness before they venture to risk a trip in the new *Victoria and Albert*.

Lightship No. 72.—The new United States lightship for the station on the Diamond Shoals, off Cape Hatteras, was launched at the new shipyard of the Fore River Engine Co., at Weymouth, Mass., September 10. She was christened by Miss Frances A. Killilea, of East Boston. This vessel is one of the new type of steam light vessels, so that she will be able to keep her station in all kinds of weather. Her dimensions are: Length, 112 ft.; beam, 28 ft. 6 in.; draft, 11 ft. 6 in.; displacement, about 600 tons. She will be fitted with three decks, one smoke stack and two beacon masts. The lights, of which there are three for each mast, will be fitted both for electricity and oil, the height of the light from the water line being about 60 ft. The electrical lightship equipment consists of six 100 c. p. 100 volt lights, the lighting of the ship being furnished by eighty 16 c. p. incandescent lamps. The propelling engine is of the single cylinder surface condensing type, of about 250 I.H.P., and is supplied with steam by two single-ended Scotch boilers built for a working pressure of 100 lb. The electric plant will be driven by two double-cylinder high-pressure engines. The vessel will also be fitted with a large Crosby chime whistle and powerful siren. Her construction is similar to that of the steam lightship which is now stationed at the South Shoal Station, off Nantucket.

American-Hawaiian S. S. Co.—The opening of the service of the American-Hawaiian Steamship Co., between New York, Pacific Coast ports and the Hawaiian Islands, which was intended to have occurred September 1, in the sailing of the S. S. *American*, from New York, has been postponed. The first vessel of the fleet to be completed, the *Californian*, was chartered gy the Government for service as a transport, and the S. S. *American*, which was intended to commence the service from here, is not yet ready for sea. The company has already secured docking facilities in New York harbor, at the foot of 42d street, South Brooklyn. The fleet of vessels will consist of the *American, Hawaiian, Oregonian, Californian*, each of 8,500 tons, and the *Alaskian* and *Arizonian*, of 12,000 tons. A monthly service will be maintained. The general agents of the company are Flint, Dearborn & Co., New York, and the Pacific Coast agents are Williams, Dimond & Co.

U. S. Submarine Boats.—Names for the six new Holland submarine boats for the Navy have been decided upon. The places of construction and contract time for the new boats are as follows: *Adder*, 9 months, Crescent Shipyard, Elizabethport, N. J.; *Gampus*, 8 months, Union Iron Works, San Francisco, Cal.; *Moccasin*, 9 months, Crescent Shipyard; *Pike*, 9 months, Union Iron Works; *Porpoise*, 10 months, Crescent Shipyard; *Shark*, 11 months, Crescent Shipyard.

SUBMARINE BOATS — FROM THE EARLIEST RECORDS DOWN TO THE PRESENT.*—I.

BY CARL BUSLEY.

Of all the branches of ship construction the ignorant have devoted most of their energy to the designing of submarine boats. According to my searches from the year 1861, in the former Prussian and the present German Navies, I have found not less than 181 different designs of submarine boats which have been submitted, whose designers were in all branches of business excepting that of ship construction. It is strange in searching over these papers to note that ministers, teachers, students, bank clerks, railroad employees and other people in the peaceable walks of life, as well as simple mechanics, have devoted their time to the designing of a death dealing submarine machine, which after particularly fantastic performances by diving, must sink at least six lines of battleships. The explanation for the great attention paid to the designing of submarine boats by landsmen and for the great interest which the public at large will always take in such apparatus lies, no doubt, in the fascination for horrors. Furthermore it is noticeable what little interest in construction of this kind has been taken by legitimate builders and designers in the different shipyards of all countries in former years. Latterly the navies of several countries have interested themselves in the question as to the outlook of the submarine boat in naval warfare and since then the builders have taken a more earnest interest in the different questions, so that it is possible to tablulate the different qualities and properties which the modern submarine boat requires. Submarine vessels can be divided into two large groups: No. 1, actual submarine boats which are intended to be entirely submerged; No. 2 partially submerged boats which remain very close to the surface and from which only single parts, such as the lookout tower, project above. The older boats are mostly of the first class and the boats of modern construction are of the second class. In order to further tabulate submarine boats they may be divided into two classes; (a) submarine boats with man power; (b) submarine boats propelled by machinery, although the boats propelled by man power, which could properly be called the pioneers, have not been built during the last thirty-five years, and therefore cannot be called modern boats. Nevertheless there are single cases nowadays in which man power is still employed.

*Translated from the Proceedings of the German Society of Naval Architects and Marine Engineers, Berlin, Germany.

CHAPTER I.

First Submarine Boats, 1604-1660.—The first attempts in the construction of submarine vessels, including the divers' bell which, of course, was known to the ancients, dates back some 300 years and appears in England at the time of the projected invasion from the great Spanish Armada. The project of the first boat of which anything definitely is known bears the date of the year 1604. It was designed by William Bourne, but was never built. The second submarine boat built of wood by Cornelius van Drebbel was tried on the Thames, in 1624, in the presence of King James I and numerous spectators. It had a capacity for fifteen persons, and was moved by means of twelve oars, which passed through the side by means of leather stuffing boxes. The boat, according to the reports, was completely submerged with its whole crew and the air in the boat was, according to the old reports, "kept pure by means of liquids." An Englishman named Day in the year 1660 remained under the water in his submarine boat at Yarmouth for a time of twelve hours, and came safely to the surface again. In his second attempt the boat sank slowly and never appeared again, and a prolonged search which was made with the frigate *Orpheus* was fruitless. The inventor as well as the rest of the crew were buried in the waves, hence none of the details of this craft remain; it is only known that it was similar to the Drebbel boat in the fact that it possessed a double bottom which could be filled with water and had to be pumped out to raise the boat. For the next 100 years all submarine boats were constructed on this principle until the Americans in

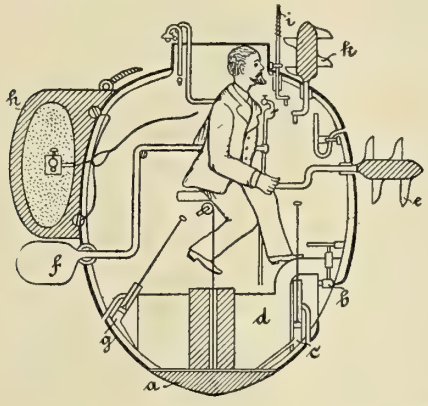


FIG 1.

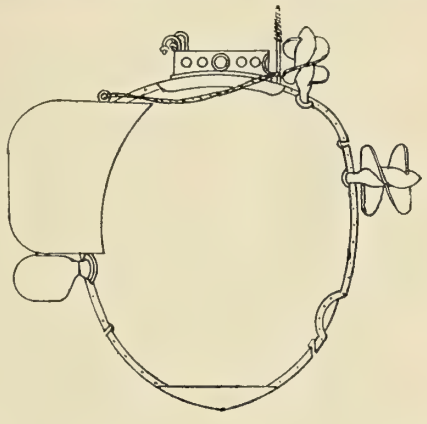


FIG. 2.

BUSHNELL'S BOAT, 1775.

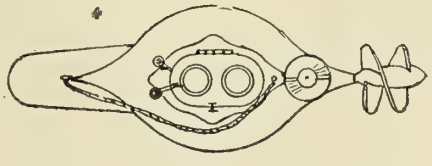


FIG 3.

the war of the Revolution took up the old ideas of the English.

CHAPTER II.

Bushnell's Boat, 1775.—At the breaking out of the war of the Revolution in the year 1775, David Bushnell, of Connecticut, built a submarine boat which, according to the sketches and descriptions, is reproduced in Figs. 1, 2 and 3. In appearance it looked like two turtle shells set back to back. It was built of wood and measured about 7 1-2 ft. dia. It carried only one man and had only enough air capacity for submersion of about a half hour. The boat was kept stable by attaching a lead weight at the bottom which could be detached by the operator at any time in order to come to the surface quickly. Furthermore there was a sea cock *b* and ballast pump *c* and tank *d*, and this, in addition to the vertical propeller *k*, enabled the boat to either rise or sink. Its speed must have been very slow as it was operated simply by a small propeller *e*, turned by hand and a small rudder *f*. The rest of the outfit consisted of the bilge pump *g*, to remove any water which may have leaked into the apparatus, a glass water gauge closed at the top and open at the bottom, in combination with a scale by means of which the operator could judge of the depth, a compass and also a torpedo filled with gunpowder and equipped with a time fuse, so arranged that it could be detached from the boat by the operator at any time. In the year 1776 it was reported that an officer by the name of Lee had made the attempt to attach the torpedo to the English blockade ship *Eagle*, of 64 guns, which lay in New York harbor. It was furthermore reported that he did not succeed in attaching the torpedo as the attaching screw of the same came in contact with some iron part of the ship's body, and when he attempted to get another position under the boat he lost his way under the water and had to discontinue his efforts at daybreak. On his return he feared that he had been discovered by the enemy and therefore disconnected the torpedo from the boat in order to lighten her and increase his speed. An hour after his return the mine exploded. The clock work in the mine was supposed to start at the moment of detaching and had been set for twelve hours. The assertions made by Lee could never be verified, and it is, therefore, very probable that right in the beginning of the undertaking he had cast the dangerous torpedo adrift, and then quietly waited on the surface of the water for daybreak.

CHAPTER III.

Fulton's Nautilus, 1797.—Robert Fulton, the builder of the first authentic steamboat, had, in the year 1797, designed a submarine boat in France. He laid the plans for the boat before the French Government, which refused to interest itself in the construction of the submarine boat. Not until the year 1801 could he perfect his boat *Nautilus*, after Napoleon had arranged to get him the necessary funds. The *Nautilus* had steel frames and sheet copper plating, as shown in Figs. 4-6. It was built in the shape of a cigar and had a length of about 24 ft., and a mean height of about 6 ft. When it floated on the surface it could be propelled by means of sails; when diving the mast was hinged downwards and, with the sails, was stowed in a groove in the top of the ship's body. Under water it was propelled by a screw which the crew turned by means of a crank. The diving and rising to the surface was effected by the filling or pumping out of water in the ballast tank, which was built in the bottom of this cigar shaped craft. In June, 1801, the *Nautilus* received a trial in the River Seine, Paris, and then was taken to Brest where the inventor, with three men, remained an hour under water at a depth of 24 ft. On August 7, 1801, Fulton remained under the water for four hours and twenty minutes. This was effected by taking a vessel of compressed air with them. He attached a mine to a hulk, and the mine was exploded promptly. Nevertheless the French Government, as well as the English Government, to whom he applied later on, decided not to follow up his idea.

CHAPTER IV.

Phillips' Boat, 1844.—In 1844 Lodner Phillips built a boat of about 10 1-2 ft. long, of elliptical section, in Michigan City. The boat was built of wood and on his first trial it collapsed at a depth of about 18 ft., and he himself narrowly escaped drowning. He built a second boat, 17 ft. long, also of wood and fitted it with a cylinder for compressed air and also certain spaces for water ballast, and continued his experiments. These gave him such satisfaction that in 1851 he built another cigar shaped boat about 38 ft. long and 4 ft. beam, and the wood hull of which was about a foot thick. In 1854 he took this boat to Lake Erie in order to dive down to the wreck of the steamer *Atlantic*, which lay in about 150 ft. of water. In the first attempt to lower the boat to this depth no crew were aboard, as they had grave fears of its strength. It collapsed and never came to the surface. In 1864 Phillips designed a craft, as shown in Figs. 7-10. This was intended for naval purposes and the United States Navy, as well as the German Navy refused to buy it. This boat was about 85 ft. long and about 8 1-2 ft. deep. It was built of 3-8 in. plate and had T iron frames, spaced about 18 in. To lower the boat and raise it to the surface he used ballast tanks which were filled with water and were emptied by means of compressed air. This compressed air was carried in the pipes shown on the upper side walls of the boat. In order to freshen up the air in the boat, the air pumps forced the foul air through a cylinder filled with water by which it was purified and the necessary oxygen was supposed to be supplied to it. It was intended to turn the screw of the boat by man power and to attain a speed of from four to five knots, which Phillips claimed he got out of his third boat in Lake Michigan with a power of four men. The reports of Phillip's trials in Lake Michigan are very meager, and it is, therefore, impossible to derive any data which would be of present value.

CHAPTER V.

Bauer's Boat, 1850.—On the 1st of February, 1851, the Bavarian artillery officer Wilhelm Bauer tried a submarine boat, Figs. 11-13, in the harbor of Kiel. An excess of pressure caused the boat to leak and it sank. It was not until nearly forty years afterward that this boat was brought to the surface again. At

the time the boat sank Bauer and two men were in it, but they were fortunate to escape with their lives, as the highly compressed air in the boat, caused by the leaks, forced the manhole off its seat and the three men shot to the surface in a huge air bubble. This boat of Bauer's was built in the machine shop of Schweffel & Howaldt in Kiel, and finished in December, 1850. Its length was 25 ft., beam 6 ft., and its greatest height 9 ft., with a total weight of about seven tons. It was built of 1-4 in. iron and with angle iron frames. The propeller was driven by means of bevel gears which at that time were driven by hand weights, as shown in the engraving. While Bauer steered the boat by means of a hand wheel *b*, two pumps *c*, *c*, were fitted forward and aft. These were used for both ballast and bilge purposes; a bellows *d* was eventually used for the purpose of purifying the air by means of water let in by a cock *e*. In later trials which he made in St. Petersburg he attempted to purify the air by spraying the sea water into the boat. The bottom of the boat was fitted with twenty-two tons of pig iron to keep it stable, and in order to bring light into the boat a deck light was fitted above. In the forward part in addition to four deck lights it was fitted with two round openings which were equipped with rubber gloves attached by means of bronze stuffing boxes, so that a man could put his hand through in an attempt to perform certain work under water. By means of the hand wheel *f* Bauer moved the weight *g* backwards and forwards in the boat in a forward and aft direction in order to give the boat certain inclinations while under water. In regard to the weakness of the hull Bauer could not devote more material for strengthening owing to lack of funds. In October, 1855, Bauer built a larger submarine boat for the Russian Government in St. Petersburg, in length about 50 ft.; beam about 12 ft., and height about 12 ft. The propeller was driven by twelve men, and it required one additional man to steer. Taken all in all it was about the same as his previous boat, the only addition was that in the middle it was equipped with a peculiar air lock so that a diver could leave or enter the boat while under water. He also replaced

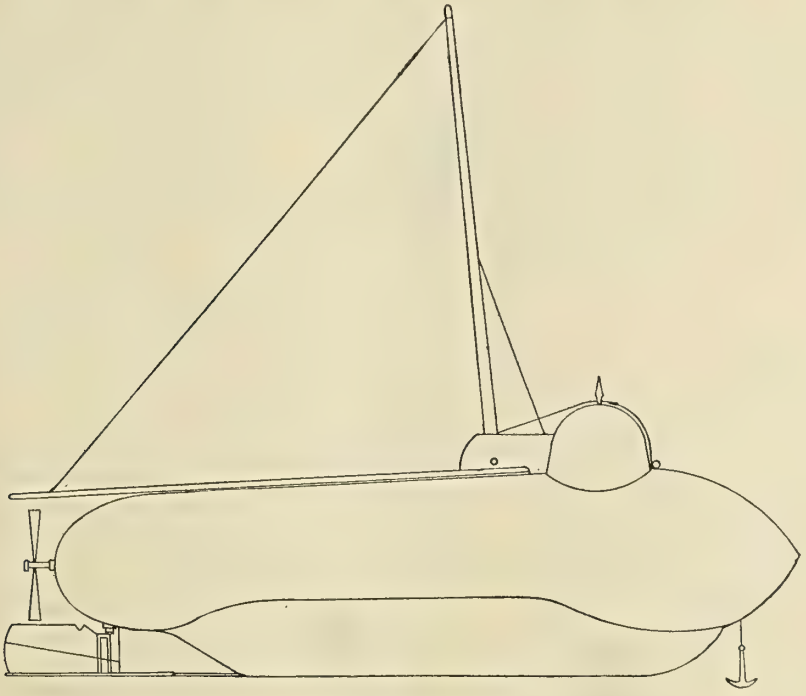


FIG. 4.

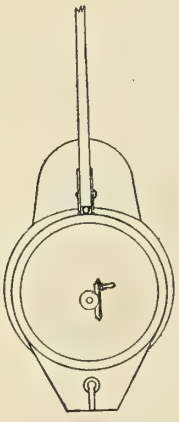


FIG. 5.

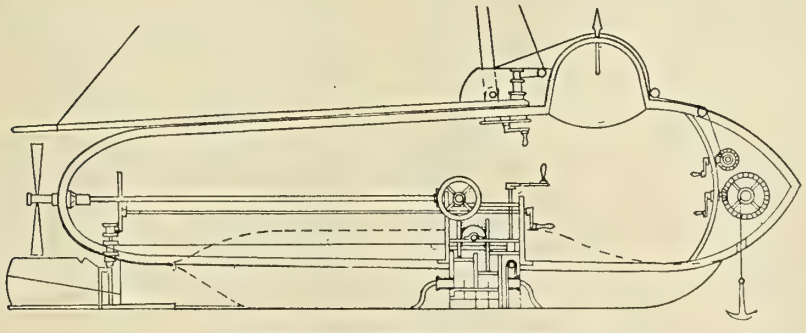
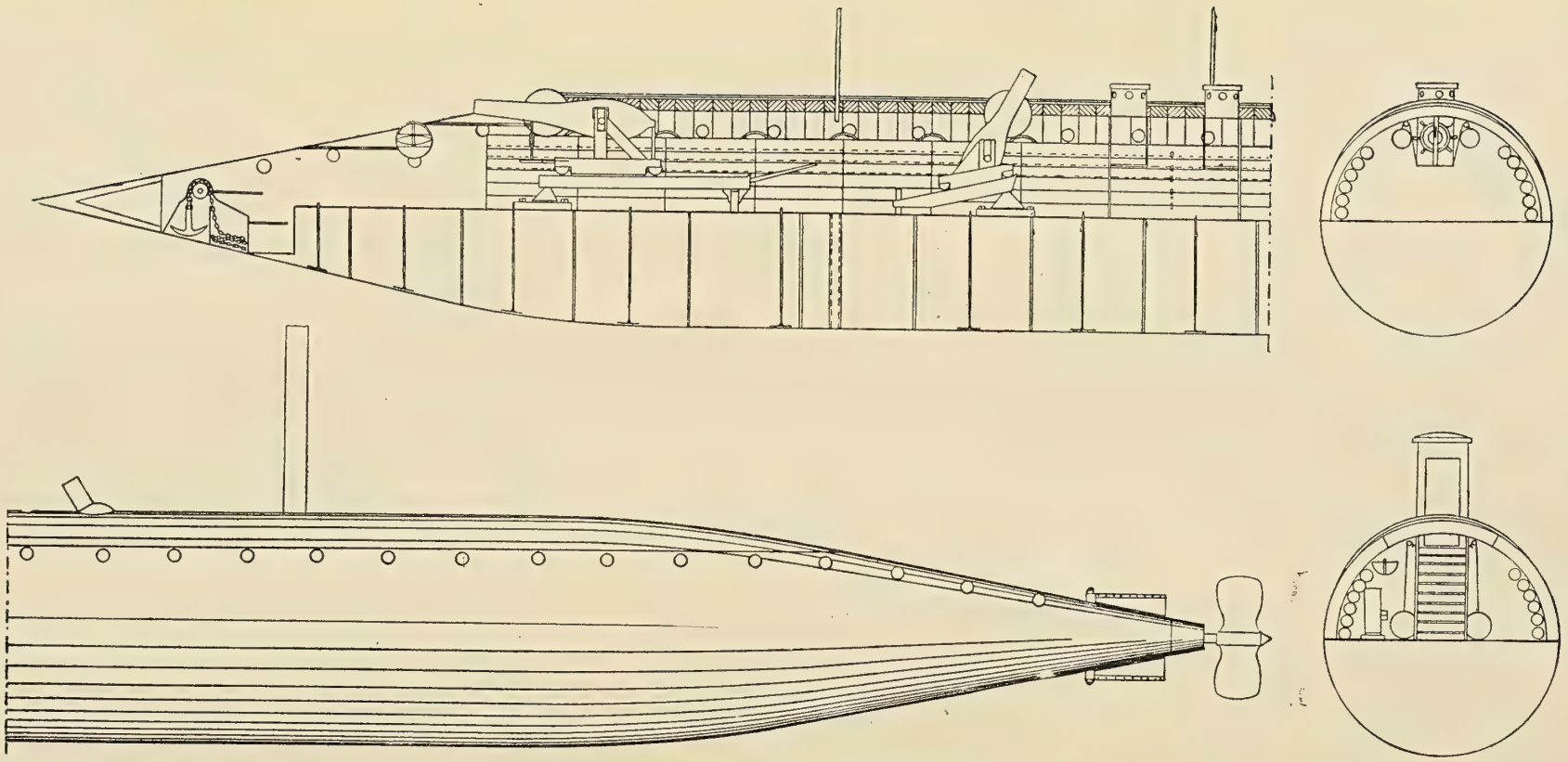
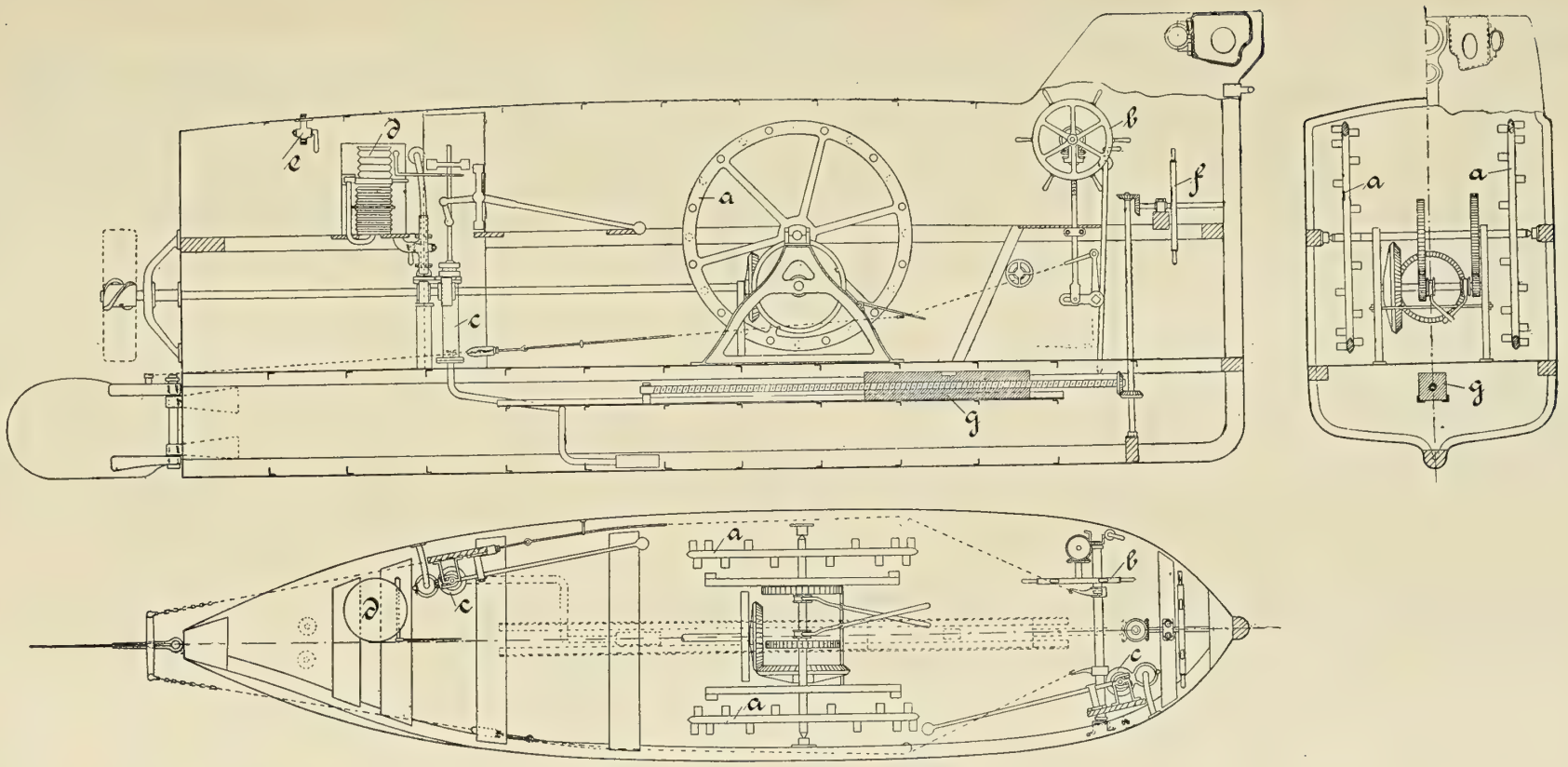


FIG. 6.—FULTON'S NAUTILUS, 1797.



FIGS. 7, 8, 9 AND 10—PHILLIPS' BOAT, 1844.—SEE PAGE 406.

the iron ballast by water ballast which was kept in three cylinders, fitted with pistons. These pistons could be moved by means of screw gear and eject the water when they wanted to come to the surface. The first trials of this boat, which occupied a length of time of about six weeks, were made with reference particularly to the purifying of the air under water and a Russian chemist, Lenz Fritsch, was asked to assist. They succeeded in purifying the air by means of artificial rain, as well as by the introduction of oxygen gas which was carried in a compressed state in flasks. By this means, it is stated, that Bauer remained nineteen hours under water with twelve men. He stated that the Russian trials were entirely satisfactory in every way and that he himself failed, as a sacrifice to political intrigue. The official reports by the Russian Government, however, state that the time required for the boat to get 3 ft. under the surface was a half hour, and that a similar time was required to come to the surface and that furthermore when it was submerged it took the time of 17 minutes to go a distance of 300 ft. and that after having gone that distance the boat had to stop owing to the fact that the crew would be completely exhausted. The trials were continued during the years 1856-7-8 without any important additional results and after the Russian Government had thoroughly satisfied itself that the boat was unfit for naval purposes it made Bauer a present of it on the condition that he was not to take the boat away from Russia. Bauer again complained of his treatment by Russia. During the four years of trials he received a monthly salary of 180 roubles, and at the termination he received the vessel itself, which had cost 56,732 roubles. In order to realize



FIGS. 11, 12 AND 13.—BAUER'S BOAT, 1850.

on it Bauer had it broken up in St. Petersburg and sold it in parts. From March, 1863, to January, 1869, Bauer had an active correspondence with the Prussian Navy with the view of building a submarine cruiser of about 115 ft. length, 20 ft. beam and 10 ft. in height, whose principal weapon was to be a 150 lb. mortar, which was supposed to stand vertical. The Vulcan works of Stettin made careful estimates of this boat and reported that it would require 287,700 marks to build it. At first Bauer wanted to drive the boat by means of treadles; later on he intended to use compressed air, according to the system adopted by Bourgois & Bruns. Still later he proposed to use a "hydraulic rotating gas steam engine" about which the marine engine builders had grave doubts. Dingler's machine shop in Zweibrücken made preliminary trials with Bauer's "petroleum gas steam engine," and soon found out that such an engine was a great deal less economical than an ordinary steam engine; therefore, the trials were abandoned. The inventor, however, attributed this to the jealousies of the engineers, as he had done in other cases when the unpracticability of his ideas were presented to him. The general idea seems to have been that Bauer had been wronged, but the reports of the Navy show how his different ideas, starting with the submarine boat, submerged artillery, power machines and balloons were all formally tested by a commission of competent men who were always friendly inclined to him. The Government naturally could not take part in all of these unripe and improbable projects. It is not to be denied that Bauer, although a man of great activity, lacked technical training and knowledge of natural laws which would explain his self-assertion and optimism.

U. S. LAWS REGULATING THE IMPORTATION OF MATERIALS FOR THE CONSTRUCTION AND REPAIR OF VESSELS.

In the shipping trade legal questions regarding the importation of materials, etc., for use in the construction of repairs of vessels often arise. It is of interest, therefore, to note decisions and rulings which have been made in recent cases and which are accepted as the law at the present time.

It will be remembered that the liner *New York*, belonging to the International Navigation Co., lost one of her screws and tail shaft on a recent westbound trip and that the lost articles were replaced by spares stored in Southampton for use in such emergency and sent over here to be put into the ship at Newport News. No duty was paid on this machinery and the authority for this action of the custom officials is contained in the following opinion of the Attorney General of the United States which was rendered to the Secretary of the Treasury in a somewhat similar case which arose in the early part of last year. The opinion is as follows:

DEPARTMENT OF JUSTICE.

February 24, 1899.

SIR: In your communication of the 14th you submit the question whether you have the power to permit a piece of machinery known as a "screw boss" brought into the harbor of New York by the *Friedrich der Grosse*, for the purpose of replacing a defective piece in the steamship *Kaiser Wilhelm II*, of the same line—North German Lloyd—to be transferred in that harbor under proper safeguards from the former to the latter vessel without the payment of duty thereon.

It appears that the screw boss sought to be transferred is a duplicate piece of machinery, designed and made especially for the *Kaiser Wilhelm II* and kept on hand at the home port (Bremen) for use in case of emergency. Duplicate pieces of the more important parts of the machinery of this vessel were manufactured at the time of the building of the engines and machinery, and have been kept on hand since, so that in case of accident a broken or defective piece of machinery may be replaced without delay. The smaller pieces are carried on board the ship, but on account of its weight (6 tons) the screw boss was kept at Bremen until needed.

Under the circumstances stated I am disposed to regard this duplicate piece of machinery, not as an article imported from a foreign country and subject to duty under our custom law, but as a part of the equipment originally provided for and belonging to the steamer *Kaiser Wilhelm II*, which you may permit to be delivered to it by its sister ship without the payment of duty.

In the recent case of *The Conqueror* (166 U. S., 110) the Supreme Court held that a steam yacht built abroad and purchased by a citizen of this country was not subject to duty upon being brought into the port of New York. Respecting the question of this steam yacht, the court, speaking by Mr. Justice Brown, said, page 115:

"She is not imported or taken into the country in the ordinary sense in which that term is used with reference to other articles, does not become commingled with the general mass of property, and is employed precisely as she might be legally employed by her foreign owners, or by an American leasing her from such owners. Other articles are dutiable, not because they have been purchased, but because they are actually imported and become the subject of sale and commerce within the country."

In support of its view that a vessel is not dutiable, the court cited *United States* v. *A Chain Cable* (2 Sumn., 362) and *The Gertrude* (2 Ware, 181) involving the dutiability of parts of the equipment of a vessel, and therefore peculiarly pertinent in considering the question submitted.

In *United States* v. *A Chain Cable*, it was held that the chain cable which was purchased at Liverpool by the master of the ship *Marathon* to supply the place of a hempen cable which had become unseaworthy before the arrival of the ship at Liverpool, became a part of the equipment of the ship, and was exempt from duty, although after the ship had returned to Boston it was taken from the vessel and loaned for temporary use in launching a ship at Medford. Although attached from the ship while thus being used, it retained its character as a part of the equipment of the ship, and was therefore exempt from duty.

In *The Gertrude*, it was held that the tackle, apparel and furniture of a foreign vessel wrecked upon our coast, and landed and sold separately from the hull, were not goods, wares and merchandise imported into the United States within the meaning of the revenue laws. The case was put upon the ground that the rigging and apparel of the ship are a part of the ship, and therefore not merchandise in any other sense of the word than that in which the ship herself is. Judge Ware used the following language, which was approved by Mr. Justice Story on appeal to the Circuit Court (3 Story, 68, 71. 76):

"If we look through the whole of the numerous acts of Congress laying duties on merchandise imported, as well as those regulating the question of the same, we shall find they uniformly contemplate the cargo; they refer to articles having the quality of merchandise in the ordinary and most popular sense of the word. They refer also to goods intended to be introduced into the country for sale and consumption, or for the general purpose of commerce."

I understand it to be true that under the ruling of your department, the racing rigging of a yacht which cannot be used in crossing the ocean, and is, therefore, brought back to this country on a steamer, is admitted free of duty because it is treated as a part of the yacht itself.

If the *Kaiser Wilhelm II* had itself brought the duplicate screw boss into the port of New York, the right to use it free of duty would hardly be questioned. The case is not materially changed by its being brought over in a sister ship and transferred in the harbor of New York, without any landing in the original sense. The duplicate

screw boss, like the original, was made and delivered abroad to the steamship company for the *Kaiser Wilhelm II.* It then became a part of the equipment of that ship, to be used when required. At present it is indispensable. It is not imported for sale or consumption here in the original sense. It is brought over to relieve the disabled ship of a friendly nation, detained in one of our ports for repair.

Upon the whole, without further discussion, let me say I take the view, you may permit the transfer and delivery to the *Kaiser Wilhelm II,* of this part of its equipment without exacting any duty.

Very respectfully,

JOHN K. RICHARDS, Solicitor-General.

Approved, JOHN W. GRIGGS,

The Secretary of the Treasury.

It is provided in Section 12, of the tariff act of July 24, 1897, "That all materials of foreign production which may be necessary for the construction of vessels built in the United States for foreign account and ownership, or for the purpose of being employed in the foreign trade, including the trade between the Atlantic and Pacific ports of the United States, and all such materials necessary for the building of their machinery, and all articles necessary for their outfit and equipment, may be imported in bond under such regulations as the Secretary of the Treasury may prescribe; and upon proof that such materials have been used for such purposes no duty shall be paid thereon. But vessels receiving the benefit of this section shall not be allowed to engage in the coastwise trade of the United States more than two months in any one year, except upon the payment to the United States of the duties of which a rebate is herein allowed: *Provided,* That vessels built in the United States for foreign account and ownership shall not be allowed to engage in the coastwise trade of the United States."

Section 13 further provides, "That all articles of foreign production needed for the repair of American vessels engaged in foreign trade, including the trade between the Atlantic and Pacific ports of the United States, may be withdrawn from bonded warehouse free of duty, under such regulations as the Secretary of the Treasury may prescribe."

Section 14 provides, "That all articles of foreign or domestic production needed and actually withdrawn from bonded warehouses and bonded manufacturing warehouses as supplies (not including equipment of vessels of the United States engaged in foreign trade, or in trade between the Atlantic and Pacific ports of the United States) may be withdrawn from bonded warehouses, free of duty or of internal revenue tax, as the case may be, under such regulations as the Secretary of the Treasury may prescribe; but no such articles shall be landed at any port of the United States."

It will be noted that these provisions of law are to be carried out under regulations to be provided by the Secretary of the Treasury, and in the new issue of such regulations which has just appeared the following provisions will be found:

"The word 'materials' as used in Section 12 may be understood as generally including all imported merchandise adapted for use in the construction of a vessel and of her machinery. Among the articles which would for the purposes of this law be regarded as 'materials' are the following: Lumber, timber, hemp, manila, copper and composition metal in plates or bars, iron and steel plates, anchors, bars, tees, bulbs, panel beams, rivets, rods, bolts, nuts and screws, rolled or forged bar plate, angles or bar plain finished or shaped, oakum, and cement.

"The word 'articles' as used in said section is sufficiently comprehensive to include everything which is suitable for use for the purposes set forth in the act.

"The equipment of a vessel is that which prepares her for a voyage, as rigging, sails, anchors, cables, chains, etc. The provision regarding 'equipment' does not cover articles used as 'supplies.' At the time of the withdrawal from bond of any materials or articles under said section, the person or firm withdrawing the same shall make oath, stating the purpose to which the merchandise is to be applied, giving the name and description of the vessel, the name and residence of the owner, and the place at which she is to be built or repaired. A bond will be required in the penal sum equal to double the duties on the full value of the merchandise. The above bond as well as the regular bond covering the original warehouse entry of the material so withdrawn will be canceled on the production of suitable proof of the proper disposition of the merchandise. The proofs include the oaths of the person who made the withdrawal, of the master builder and of the part owner or agent of a vessel, all of whom shall certify that the merchandise has been used entirely in the construction or repair of the vessel and for no other purpose."

Section 2,982 of the revised statutes also provides the privilege of purchasing supplies from public warehouses free of duty and shall be extended under such regulations as the Secretary of the Treasury shall prescribe, to vessels of war of any nation in ports of the United States which may reciprocate such privilege toward such vessels of war of the United States in its ports. Under this law the Secretary of the Treasury has decided that the privilege accorded by this section will be allowed to vessels of war of the countries hereinafter specified, it having been ascertained that a similar privilege is accorded by the Governments of those countries to vessels of war of the United States when visiting their ports, viz.: Austria, Chile, Corea, Denmark, England, France, Germany, Greece, Holland, Italy, Japan, Roumania, Sweden, Norway, and Venezuela. The regulations of the Treasury provide that when supplies are withdrawn from bond for the use of a war vessel, the withdrawal should be accompanied by a certificate from the commanding officer of the vessel, showing that the supplies are intended in good faith for the use of the officers and crew of the vessel, and not for sale; the supplies should also be loaded on board of the war vessel under the supervision of an officer of the customs, who will be required to certify that they were duly placed on board the vessel.

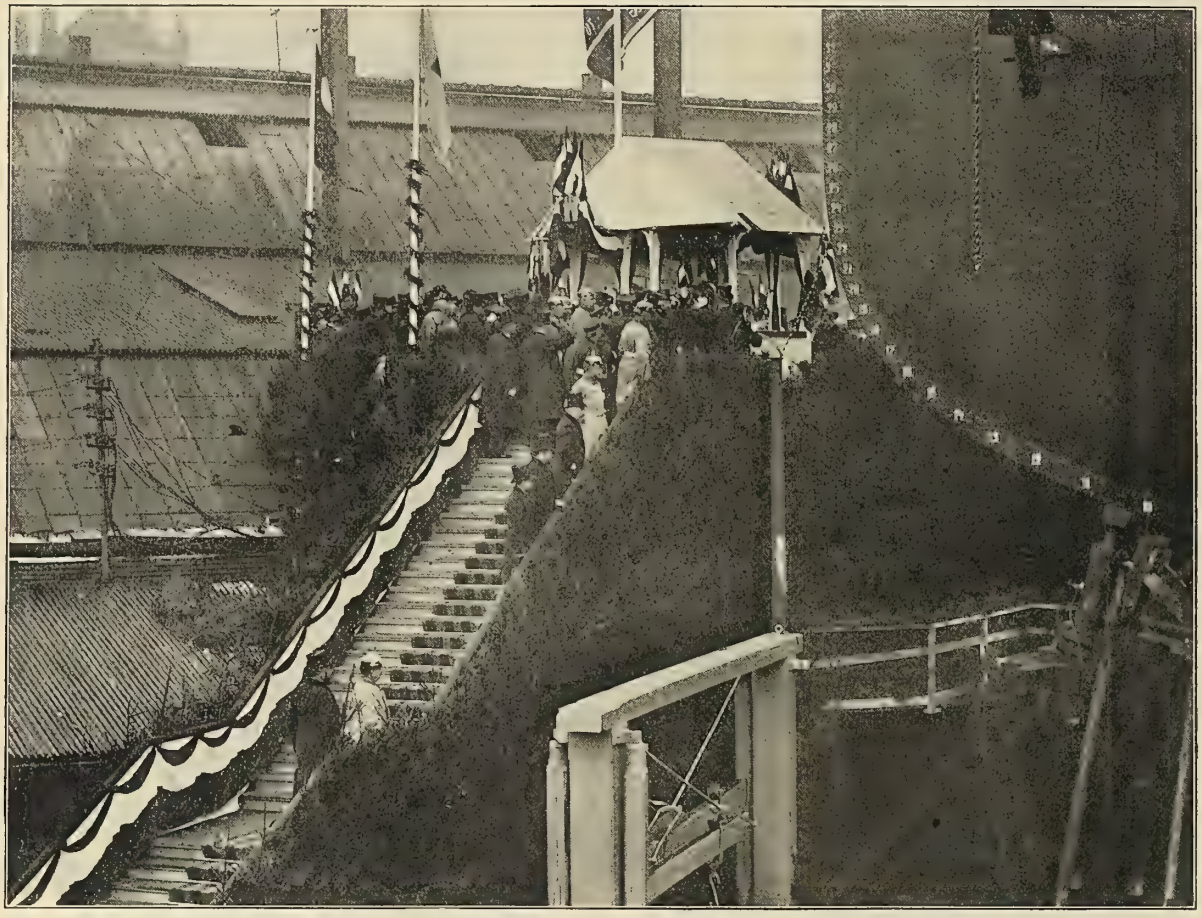
There is a provision in Section 3,114 of the revised statutes of the United States to the effect that the equipments purchased for, or repairs made in, a foreign country upon a vessel enrolled and licensed under the

laws of the United States to engage in the foreign and coasting trade on the northern, northeastern and northwestern countries of the United States shall on the first arrival of such vessels in any ports of the United States, be liable to entry and the payment of a duty of 50 per cent ad valorem on the cost thereof in such foreign countries. If the master of the vessel shall fail to make entry and pay duties as required by law, the vessel, with her tackle, apparel and furniture shall be seized and forfeited. There is a further provision in Section 3,115 of the revised statutes that any equipments or repairs in a foreign port which are absolutely necessary to ensure the return of the vessel to this country or to her port of destination, such as would be caused, for instance, by stress of weather or accident, shall not be subject to the provisions of Section 3,114. Under this law a number of United States General Appraisers recently decided that in the case of the steamer *Islander* the following expenses for repairs were within the meaning of Section 3,114, and that the vessel would be required to pay the duty of 50 per cent ad valorem on the cost of such repairs upon her arrival at Cape Vincent from New York to which she was bound. The repairs were: One smoke stack, $36.00; one crank pin, $20.00; carpenter work, $20.00; two iron shields, $3.00; soft patch on boiler, $157.00. Total, $236.00.

An honest difference of opinion as to "absolutely necessary" repairs might easily arise.

ADDITIONAL PARTICULARS OF THE NEW TRANSATLANTIC RECORD BREAKER DEUTSCHLAND.

It is evident that the new Hamburg-American liner *Deutschland* intends to come up to expectations in the matter of speed, for in an east bound run last month she eclipsed her best previous performances and incidentally made a new record. The new flyer passed the Sandy Hook lightship, bound out, at 1. 30 P. M. on September 5, and arrived off the Scilly Islands at 10.40 P. M. September 9, passing the Lizard at 12.35 A. M. on September 10. A short course, 2,982 knots, was covered, and the record time of passage was 5 days, 7 hours and 38 minutes. An average speed of 23.36 knots was maintained during the trip, and the daily runs were: 507, 535, 540, 549, 545, and 306 knots.



EMPEROR OF GERMANY AND GOVERNMENT OFFICIALS AT LAUNCHING OF THE DEUTSCHLAND.

In our July issue we gave views of the engines and boilers of the new liner, as well as a general description of her machinery equipment, and we now supplement that information with detail dimensions of the machinery and interesting views of the hull of the vessel at the builder's yard. It will be remembered that the *Deutschland* was laid down with the view to service as an auxiliary cruiser in war time, and this accounts for many of the special details of construction. In the stern view the totally submerged rudder and the protection for the rudder stock will be no-

ticed. The propellers are carried close in and well under the hull, a large opening being provided just forward of the rudder after the fashion of a single screw vessel. Spare steering gear is also fitted below the water line and there are the usual cruiser gun platforms on the upper deck. Rapid fire guns with their mounts for the equipment of the *Deutschland* are to be ready at Hamburg and Kiel, so that at the briefest notice the vessel can be converted into a warship.

In construction the new liner meets, and in some instances exceeds, the requirements of the classification societies, and she is also fitted out in conformity with the German, British and U. S. Government rules.

For ready reference we hear repeat the general dimensions of the *Deutschland*. Length over all 668 ft. 6 in., between perpendiculars 662 ft. 9 in., beam mouded 67 ft., depth 44 ft., dead weight capacity 6,000 tons, gross tonnage 16,000 tons, displacement at 28 ft. draft 23,000 tons. On the maiden trip the maximum I. H. P. recorded was 36,600, but at the regular rate of revolutions, 78 per minute, 36,000 I. H. P. is said to be developed.

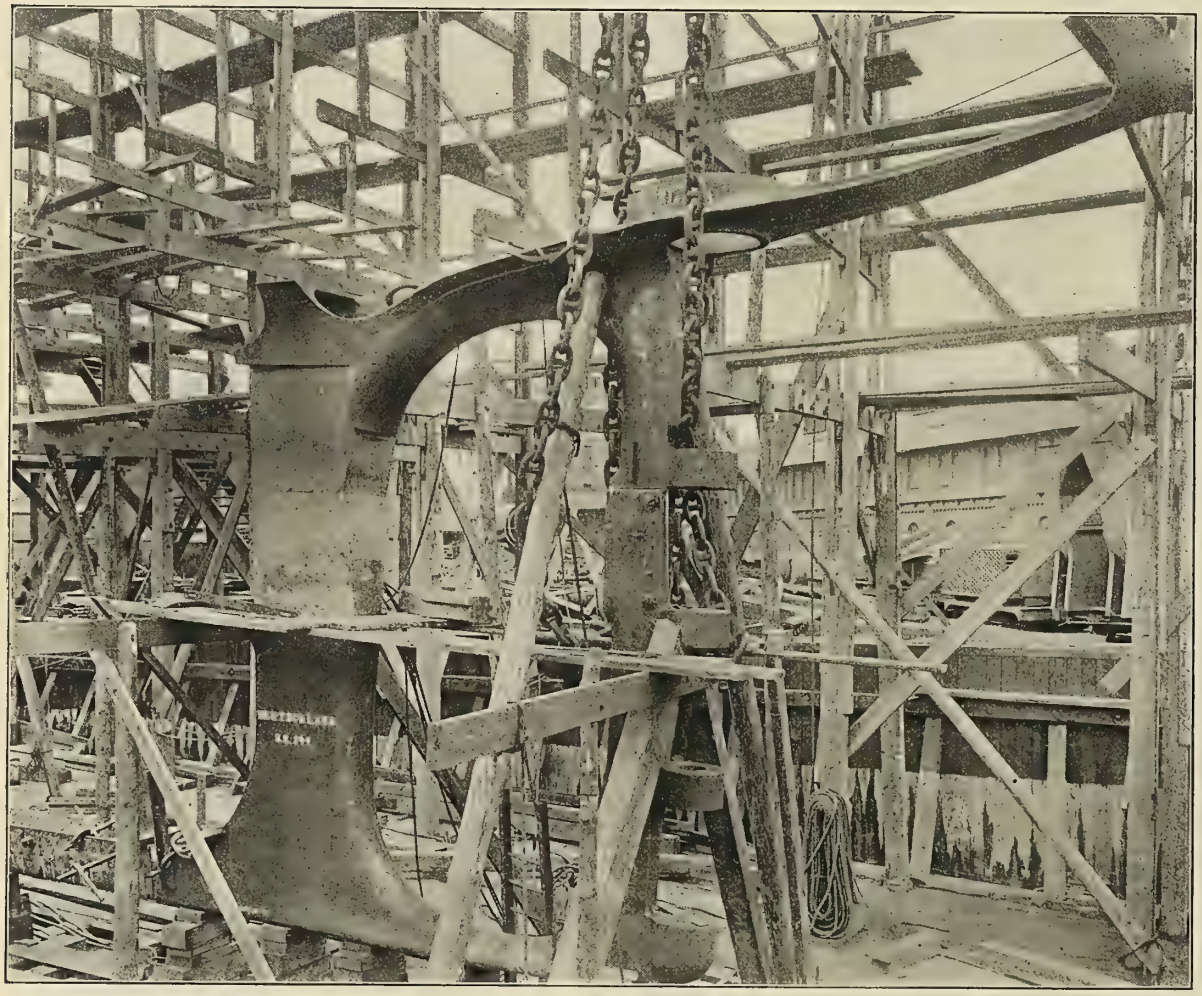
Siemens-Martin steel is the material used for the hull. This contains eight decks in all, viz.: Hold deck, steerage deck, main deck, upper deck, promenade deck, orlop deck, boat deck and sun deck. The steerage, main and upper decks run continuously from end to end. The launching weight of the hull exceeded 9,200 tons. In designing the vessel the question of subdivision was carefully considered and the ship has a cellular double bottom, divided into twenty-four tanks including the fore peak and after peak tanks. To take the drainage the usual number of wells are fitted. Under the boilers there are four ballast tanks which hold about 66,000 U. S. gallons of fresh water for extra boiler feed. The hull proper is divided into twenty-one water-tight compartments. A system of 8 in. piping connects the tanks and a duplex ballast pump located in the forward fireroom is

STERN VIEW OF T. S. S. DEUTSCHLAND TAKEN SHORTLY BEFORE THE LAUNCHING AT THE VULCAN WORKS.

capable of handling 280 tons of water an hour. This pump connects with all tanks and has also an outboard discharge. An auxiliary ballast pump with separate 4 in. system of piping is available in case the main ballast pump fails.

The engines, as our readers are aware, are each of the six cylinder, quadruple expansion, high-low tandem, four crank type, and are designed so as to reduce vibration, according to Mr. Schlick's patent system of balancing. The dimensions of the cylinders of each engine are: Two high pressure cylinders, each of 36.64 in dia., one first intermediate cylinder 73.67 in. dia., one second intermediate cylinder 104.61 in dia., and two low pressure cylinders 106.38 in. dia. The common stroke is 72.89 in. All the cylinders are jacketed. Looking aft the sequence of cylinders is as follows: 1st crank, first intermediate; 2d crank, forward low and high pressure cylinders (tandem); 3d crank, after low and high pressure cylinders (tandem); and 4th crank, second intermediate. The crank shaft, illustrated in our July issue, is built up of four sections, and measures: length 59 ft. 33.8 in., outside dia. 25.2 in., weight 22,330 lb. The crank and propeller shaft forgings are of nickel steel made by Krupp in Essen. The main engine bearings have exceptionally large surfaces and are liberally proportioned.

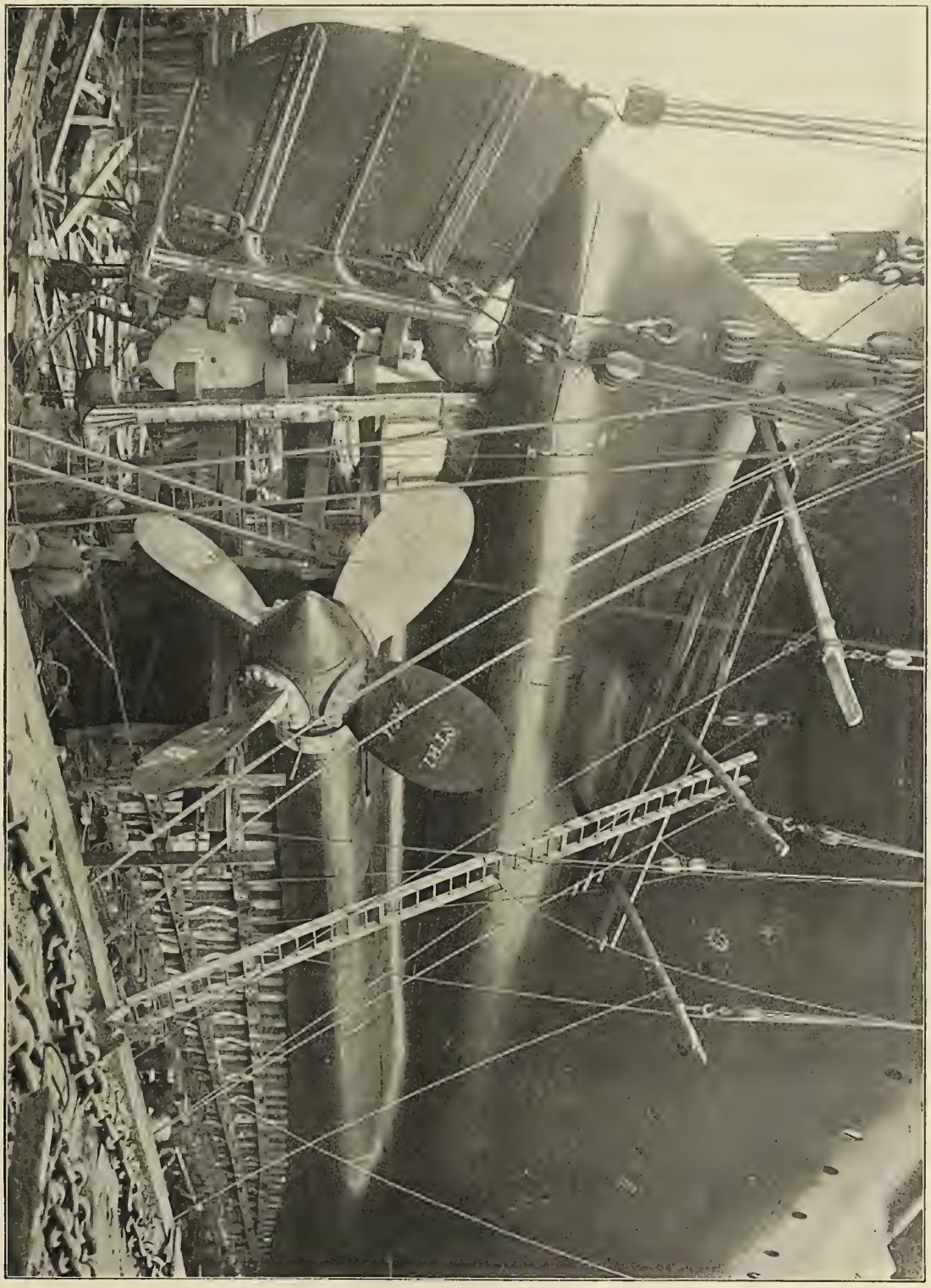
The engine framing is very similar to that of the *Kaiser Wilhelm der Grosse*, also built at the Vulcan Works. The frames are steel castings, sixteen in number for each engine, each frame receiving the horizontal thrust of a guide shoe from the crossheads. There are sixteen guide shoes for each engine, four to each crosshead, two for going ahead and two for going astern. The shoes are all of the same size, and are lined with white metal. The intermediate pistons are fitted with tail rods. The pistons are steel castings. The high pressure pistons are fitted with Ramsbottom's rings, the intermediate pressure with Buckley's rings, and the low pressure with Peck's patented rings.



STERN FRAME OF T. S. S. DEUTSCHLAND SET UP ON THE BLOCKS.

The valves are worked by the ordinary Stephenson double bar links. The high pressure valves obtain their motion from a rocker shaft, which is placed upon the low pressure cylinder covers. One end of the rocker arm is attached by means of links to the valve rod, and the other end to a link rod passing between the intermediate and low pressure cylinders,

and is attached to the valve gear below. The high pressure cylinders have one piston valve each. The intermediate pressure cylinders have two piston valves each, the stems of which are connected by a yoke in the ordinary way. Each low pressure cylinder has a flat slide valve, operated by two valve rods connected by a yoke. All valves except those of the high pressure cylinders are equipped with balance pistons. The weigh shafts are placed on the outboard side of the engines, and are controlled by Brown, Glasgow, combination steam and hydraulic reversing engines. In addition the usual hand



NEAR VIEW OF STERN OF T. S. S. DEUTSCHLAND, SHOWING DETAILS OF RUDDER AND PROPELLERS.

reversing gear is supplied. The turning engine is placed close to the main engine, and is of the ordinary double cylinder simple engine working a worm which engages the wheel on the main engine shaft.

Each engine room contains a main condenser of circular cross section. Condenser tubes are seamless, 3-4 in. dia., and tinned inside and outside. The total cooling surface for each main condenser is about 21,300 sq. ft. Each engine room also contains one independent air pump, built by the George F. Blake Mfg. Co. The pumps are of the vertical "Twin" type, double acting in the steam ends and with single acting water ends. The steam cylinders are 18 in. dia., water ends 44 in. dia., with a common stroke of 24 in. Cooling water to the surface condensers is supplied by two centrifugal pumps, both driven jointly by one compound engine. These pumps can also draw from the bilges. The discharge of the circulating water from the condenser is under the water line. Two double Weir feed pumps are fitted in each engine room, having steam cylinders 12 in. dia., and water cylinders 8 in. dia and 12 in stroke. The inboard feed pumps draw from the hot well and deliver the water into a Weir feed-water heater. The outboard pumps take the water from the heater and delivering the water through a Claussen, Glasgow, oil extractor, pump into the boiler feed line. Besides these connections the feed pumps can also draw from the fresh water tanks and pump directly into the boilers or overboard. The steam used for heating the feed water is taken from the second intermediate receiver and the auxiliary exhaust.

A Morrison radial type evaporator is used for making fresh water. This evaporator is capable of delivering about 23,770 U. S. gallons in twenty-four hours. The vessel is also fitted with an auxiliary condenser for use in port. The condenser has 861 sq. ft. of cooling surface. Condensing water is furnished by one auxiliary centrifugal pump. When this condenser is used at sea circulating water can be furnished by the main circulators.

The main boilers are sixteen in number, twelve double ended and four single ended. They are placed in four groups of four boilers each, viz.: three double and one single ended in a group. Each group of boilers has one smoke stack, making four stacks in all. The dimensions of the double ended boilers are: Outside dia., 16.58 ft.; length, 20.33 ft. They are each fitted with eight of the Morison type of furnaces, each 3 1-2 ft. dia. Steam pressure carried is 220 lb. Total grate surface of all boilers is 2,200 sq. ft. and total heating surface 84,250 sq. ft. The diameter of the tubes is 3 in. and all are supplied with retarders. There are 112 furnaces in all. Howden's system of hot forced draft is used, air being supplied by fans driven by compound engines. The arrangement for each group is somewhat novel. Two fans, 84 in. dia., are placed on top of the double ended boilers of a section, while the engines are over the single ended boiler in the same section and are directly connected to the fans by means of a long shaft.

There are two Blake simplex pumps 12 in. by 12 in. by 16 in., capable of pumping from the sea, the bilges and the double bottoms, and discharging overboard or into the fire mains. Each of the four boiler sections contains one Blake vertical duplex auxiliary feed pump, size 12 in. by 8 1-2 in. by 12 in., capable of feeding the boilers of that section. The pumps have connections which enable them to draw from the sea, fresh water tank, from the boilers and from the bilges, and discharge overboard or into the boilers. Water to the sanitary system is supplied by two Blake vertical simplex pumps, size 12 in. by 12 in. by 16 in., and also by two pumps directly connected to the main engines.

The thrust shafts 25.2 in. dia., are placed immediately aft of the main engines, and each shaft has twelve thrust collars. The thrust blocks are of the ordinary horse shoe pattern, with white metal facings and supported in the usual manner.

The entire line shafting is carried inside of the hull extensions, according to the Lundborg design. The line shafting is 25.2 in. dia., and the entire length of each set of shafting is about 215 ft.

The propellers are four bladed with bosses of cast steel and blades of Parsons manganese bronze. The diameter of the propeller is 23 ft. and the pitch adjustable from 33 to 36 ft.

Great attention has been paid to the sanitary arrangements, the bath-rooms being thirty-three in number, of which sixteen are first class, six for the suites, six second class, one for the captain, two for the engineers, and two for the hospitals. The electric lighting plant consists of five direct connected dynamos, of which three are of 700 amperes and 110 volts, and two are of 400 amperes and 110 volts. The two-wire system is used. There are about 2,000 lamps in the circuit. The electric engines were built by Dasvel, of Kiel, and are run at 250 revolutions per minute. The plant was installed by the Algemeine Electrische Gesellschaft, of Germany.

The refrigerating machinery is placed between the two propeller shafts, and consists of carbonic acid gas machines.

The number of life boats, all of which are carried on the seventh or boat deck, is twenty-six, of which eighteen are metal life boats of the Francis patent, two are wooden, and six are of the collapsable type.

The vessel, besides having the ordinary mechanical telegraphic connections, is fitted with a complete system of telephonic connections, thus enabling the officers on the bridge to be in verbal communication with the engine room force and the steering engine room crew.

The *Deutschland* is strictly a passenger vessel, the freight accommodations being very scant. Provision has been made for 470 first class, 300 second class, and 300 steerage passengers. The crew numbers about 430, all told.

U. S. S. Oregon.—It is reported that the injuries sustained by the battleship *Oregon* are much more serious than was at first supposed. In many places the outer bottom was ripped open, and the repairs which were carried out were of the most temporary character. It is probable that the vessel will be patched up at Hong Kong so as to come home for thorough repairs.

TORPEDO CRAFT (UNITED STATES AND FOREIGN) TYPES AND EMPLOYMENT.*—II.

BY LIEUT. R. H. JACKSON, U. S. N.

PRACTICE ABROAD IN TORPEDO BOAT CONSTRUCTION.

In 1878 and 1879, England, Germany, France, and the United States built one or more fast launches of 60-100 ft. in length, and as high as 22 knots speed, to be fitted with Whitehead torpedoes. During the next five years, two or three 100-ft. boats were turned out by Thornycroft and Yarrow, principally to fill the orders of the leading foreign governments.

Germany.—In 1883 Germany decided upon a type of boat which was about 125 ft. long, 85 tons displacement, 1,000 I.H.P. and 19-22 knots, armed with two H. R. C. and two tubes. In the next seven years she added 63 of these to her flotilla.

In 1892 she built sixteen boats, 144 ft. long and 110-125 tons displacement, speed 25 knots; and in 1898 with 152 ft. length, the displacement was increased to 140 tons, apparently to obtain greater endurance, seaworthiness, and habitability. Her policy until 1898 had given her but two types of boats, sixty-three of the 125-ft. length (19-22 knots), boats distinctly for station work, and sixteen about 125 tons (25 knots), boats for operating with squadron.

In 1898 the size increased to 140 tons, and there are now building eight of 155 tons displacement.

Conjointly with the building of these boats, Schichau has built eleven larger boats, known as division boats. They have been added in the proportion of one to each seven boats, and are supposed to be the flag boats of the divisions, as well as to render aid, to a certain extent, to the other boats. They are between 250 and 300 tons, speed increasing from 21-28 knots, according to the date of building. Only the last of these boats, No. 11, has twin screws; while of the eighty-five torpedo boats already mentioned, none have twin screws. The armament of these boats, originally two 37-mm. guns, has now been replaced by 3-pdr. R. F. G. and .31 cal. machine guns, with two or three torpedo tubes, according to their displacement.

There are also twenty boats built by different firms between 1884 and 1887 that are less than 100 tons, and have twin screws.

England.—England was conservative, as usual. Her pioneer private firms were selling boats abroad before she began to build; but with her liberal appropriations, she has carried the boats forward more completely than any other nation. The history of her policy will consequently be the most instructive.

Starting with 86-ft. boats in 1878, she seemed content with watching the results of the efforts of her builders to fill the orders for one or two boats for foreign governments, till in 1885 she ordered the *Swift*, 150 ft. long, as the first attempt to get a sea-going boat. In 1885-86 she decided upon a type close to the type selected by Germany two years before, *i. e.*, 125 ft. long, with somewhat less displacement (60-75 tons), and ordered fifty-seven to be built at once.

The next year, on account of gradually increasing speed obtained by several firms, she built a boat 135 ft. long, with speed of 23 knots. In 1887, Yarrow sold a 140-ft. boat, speed 25 knots, to Spain; and Thornycroft a slightly smaller boat, speed 26 knots, to Italy.

In 1893-95, England built ten boats 140 ft. long and 100-130 tons displacement, which she tested the next year in her squadron maneuvers as well as her seventy small station boats about 125 ft. long.

These ten were the last torpedo boats built by her, the destroyer having replaced that sea-going boat for service with the fleet, leaving her ten sea-going station boats of the first class, and seventy-five vedettes for harbor defence.

Destroyers.—On account of the unsatisfactory speed of her torpedo gunboats, England, whose rôle is to protect the fleet, ordered (1893-95) thirty boats called destroyers, the rôle being to supplant the gunboat in protecting the fleet from torpedo attack; and further, having sighted the torpedo boat, to overhaul and destroy it. Thirty were built immediately, 190-200 ft. long, 220-280 tons displacement, and 27-29 knots speed. Seven slightly larger boats were built the same year, length 210 ft., displacement running up to 300 tons, and speed to 30 knots.

In 1895, during the squadron maneuvers, these destroyers were tested with such satisfactory results that England has made no addition to her torpedo boats since that time, but has increased her destroyer flotilla from 50 in 1895 to 118 in 1900, the only change in type being an increase in size and power. One of her latest laid down is as follows: Displacement, 420 tons; I. H. P., 9,000; speed, 33 knots; armament, one 12-pdr., five 6-pdrs., two tubes and four torpedoes.

Among the tests in 1895 was one to prove the power of the destroyer to catch the torpedo boat. Without any preliminary notice, twelve of the best torpedo boats, with a speed of about 20 knots in a smooth sea, were sent at full speed toward port 40 miles distant. After giving them twelve minutes' start, the destroyers were sent after them. The chase was over in eleven and a half miles, and lasted about thirty minutes. Four of the boats escaped, the highest speed logged by them being about 20 knots. Some of the boats broke down, as did two of the destroyers.

Good results with the destroyers were also obtained in firing at a target when running by at a 30-knot speed, and in discharging the Whiteheads when running from 20 to 30 knots. Experiments were also made as to the ability of the destroyers to block all the boats in port, and protect a fleet passing along a hostile coast. The results of most of the work in 1895 were kept confidential, but an extract from a letter written by a capable naval officer who took part in the operations says: "The impression left on my mind by the maneuvers was, that all the present types of boats are obsolete, and that probably no more (like them) will be built. But I believe that boats of the size of the destroyers will take their places in every navy." This certainly has been the policy of Great Britain. In 1896, in addition to the fifty already turned out of 27 knots, she laid down thirty more similar to the seven already noted, of 300 tons displacement.

FRANCE.—TORPEDO BOAT POLICY.

France in 1878 began with an 86-ft. torpedo boat of 30 tons and 19 knots, about like the *Stiletto* in our ser-

*Prize essay read before the U. S. Naval Institute, Annapolis, Md., and copyright, 1900, by R. H. Jackson, U. S. Naval Institute.

vice, but slightly smaller. In five years she acquired about fifty of these, and has built no more. When new they made from 16 to 19 knots. Her vedette boats—thirteen, including seven aluminum boats of 60 ft. and 15 tons displacement—she has shown no desire to increase. The first type (ten) she armed with 37 R. C., and on the remainder she has placed two 1-pdr. R. F. guns, and two torpedo tubes. This is now her armament for all boats except her sea-going boats.

While she was building her 86-ft. boats, third class, she also (in 1878-83) turned out eighteen 110-ft. boats, about the size of the *Gwin*.

In 1885, she made a large program for accession to her torpedo boat flotilla, and in the next four years added sixty to this *Gwin* type, though 15 ft. longer, and of somewhat less beam. All of her boats to this point were second-class boats, having less than 60 tons displacement with over 100 ft. length. At the same time a program was brought forward for building a certain number of boats of tonnage between 60 and 100, and length exceeding 100 ft. These were to be designated as first-class torpedo boats.

The type selected had the following characteristics: Length, 134 ft.; beam, 11 ft.; depth, 7 ft.; tonnage, 67, and I.H.P., 700, to give 20 knots with single screw.

From the experience obtained from these new boats a new type of first-class boat was adopted two years later, with the following characteristics: 118 ft. long, 13 ft. beam, 8 1-2 ft. draft, 79 tons, 1,300 I.H.P., 23 knots with two screws. The modifications in general terms being as follows: Adding a second engine of same size, thereby doubling the I. H. P., and giving a speed of 23 knots instead of 20. The boats now being 16 ft. shorter, 2 ft. more beam, 1 1-2 ft. more draft, on about 12 tons more displacement. This seems to have been satisfactory to the authorities for station work, as they were gradually added until in 1896 there were sixty-four of them practically identical.

In the armament of these boats she has been consistent.

The construction of sea-going boats began in 1889. In 1895 the *Forban*, built by Norman, led the world with 31.5 knots. During this time she built thirty-four 100 to 150 ton boats, length 140-160 ft., with every apparent variation in speed, armament, and coal endurance, without regard to dates of building. The armament varies from two 1-pdrs. to three 3-pdrs., this last battery being put on the smallest of the class, and the tubes varying from two to four.

Summary.—(*a*) Briefly outlining the results of France's torpedo policy, it is seen that commencing in 1878, she built second and third-class station boats, possessing, in 1885, fifty small *Stilettos* and *Gwins*. She then abandoned her *Stiletto* type, and in the next four years added sixty to her *Gwin* type, though 15 ft. longer and somewhat narrower. At the same time she made her first attempt with a first-class boat, *i. e.*, 60-100 ton boats, and laid down ten resembling the *McKenzie*, but 43 ft. longer and of a little less beam. These were evidently failures; for shortening the length 16 ft., increasing the beam 2 ft., and using twin screws, she has reached her present type, which will be referred to as the French station type.

She seems to have been unable to decide upon a sea-going type.

Her present flotilla comprises fifty *Stilettos*, seventy-five *Gwins*, and ten *McKenzies*, none of which types she would duplicate. Also sixty-three first-class, and thirty-five sea-going boats, of 120-130 tons of questionable sea-keeping power. It may be safely assumed that none of these are capable of remaining and operating with the fleet, but must always rest on a station as a base.

(*b*) Germany seems to have obtained a good type in her sixteen boats of 125 tons design, their principal objection (a bad one, however) is that they have single screws. Any boat required to operate at sea, more or less independently, must have two engines to insure her safety. A torpedo boat comes into port under one engine far oftener than is supposed.

(*c*) England's last sea-going torpedo boats (ten), built in 1896, about the same size as Germany's (110-130 tons) boats, but with twin screws, were satisfactory, but had not the sea-keeping power demanded by her policy, nor could they fulfill the tactical demand for the destruction of the enemy's boats, called for in her offensive rôle. Hence her destroyer.

France, ever trusting in her ingenuity and theoretical schemes, which lean toward the performance of miracles, has now directed her attention to submarine marvels, after having created an enormous flotilla of small boats, practically none of which are sea-keeping.

Conclusion.—From all this we find that a good twin-screw, sea-going, but not sea-keeping, boat can be obtained between 110 and 130 tons, while the destroyer must be over 250 tons, with a tendency to increase its size. England's largest destroyer, the *Express*, is 420 tons and 9,250 I.H.P.

Having looked over the navy list of the leading powers of Europe, it is seen that they have quite as heterogeneous a collection of boats as are shown on our own list, with the difference that they have large groups of each. This does not mean that they have found a need for each group, but rather that they represent the costly steps leading to present practice. The present practice shows but little variety in types.

These then are the types that foreign practice would lead us to adopt. After considering the information from the other two sources, we will compare them.

Secondly.—The performance of our own boats during the Spanish War.

As the boats made no torpedo attack, the principal points upon which information can be gathered are, habitability, seaworthiness, sea-keeping power, and durability. An investigation of these points will divide the boats into station and sea-keeping boats, and, in addition, the destroyer class. A brief record of the performance of the different boats that took part in the Spanish War will be given, starting with the smallest of the class.

The *Gwin* and *Talbot*, sister boats of 46 tons displacement, one engine, one boiler, and speed 20 knots, arrived at Key West the middle of July, having come down through the canals as far as Ocracoke Inlet. The *McKee*, a boat of the same class, except that she is equipped with two boilers, came at the same time. About the first of August, in response to the restlessness of their commanding officers, they were sent out on the blockade off the north coast of Cuba from Cardenas to Cay Frances. Their special function was

to pass in among the shallow inlets behind the Keys and capture and destroy all cargo boats, sloops, schooners, and fishermen, suspected of rendering assistance in discharging the cargo of blockage runners. The steamers entering these ports could not get up to the towns for lack of water, yet could remain concealed behind some of the Keys till discharged. The *Foote* and *Cushing*, 140 and 105 tons respectively, twin screws and two boilers, were also on this expedition. It was expected that large ships of the blockading squadron would be found in the neighborhood; from these supplies were to be drawn, and upon them they could depend for defence from the Spanish gunboats, of which there were several in the principal ports. These parent ships turned out to consist of one or two auxiliary converted yachts that were but poorly equipped with coal and water; and even they were soon separated from the boats. The *Talbot* having smashed in her bow in a night collison while carrying dispatches, the other boats cruised in pairs among the Keys, chasing and capturing all the craft that dared to appear, even in sight of gunboats, that usually contented themselves with pouring dense volumes of smoke from their funnels upon sighting the torpedo boats. The gunboats ordinarily lay alongside of the docks, content to be let alone.

On this cruise, one of the torpedo boats, having but a single boiler, was troubled with a leaky tube. So, lying under Piedras Key, she cut out and replaced the tube, and brought in boats enough water from a cistern on that island, to again fill the boiler. Just how long these little craft could have remained on this sort of duty it is difficult to say, as any passing vessel could supply them with coal and water, and a little hard bread and canned meat. When they returned from the blockade on the 10th of August, the preliminaries of peace having been arranged, they could certainly have remained a week longer without any additional supplies.

These boats then showed their ability not only to operate from a fixed base, such as Key West, but also to utilize the larger vessels on the blockade as a base, and efficiently carried out the rôle of shallow-draft gunboats is passing among the keys and suppressing all commerce across the interior waterways, though they were never designed for this work.

Cushing, Ericsson, and *Morris.* These somewhat larger station boats did not have very much duty during the war. The *Cushing* and *Ericsson* saw such very hard dispatch duty just before the war, as to necessitate very extensive repairs. The *Cushing* accompanied the other boats on the blockade on the 1st of August, and stayed out until the boats were recalled from the blockade. The *Ericsson,* though constantly breaking down and returning to port, scored a point in being the only torpedo boat on the scene of action on the day of the Santiago fight. This was due more to the ingenuity, patience, and perseverance of her commanding officer, than to any good quality of the boat. The *Morris* did not arrive till near the end of the war and did not leave Key West.

The *Foote* and the *Winslow* went out on the blockade of Matanzas, Havana, and Cardenas, at the outbreak of the war. The *Winslow's* career was about finished on the 10th of May, when she was disabled by the gunboats at Cardenas. She had seen several days of service on the blockade up to this time.

The *Foote* remained on the blockade for about seven weeks, coming in twice for mail and dispatches and fresh food for herself and the other ships occupying that station. She was then withdrawn, being relieved by the *Leyden.* After about two weeks' overhauling at Key West, principally renewing the boiler fronts, she was again ready for work, but was not sent out again till August, when she returned to the blockade of Cardenas and ports to the eastward, as already stated. She remained there till recalled at the end of the war.

Porter and *Dupont.* These two boats were at Key West at the outbreak of the war. They went on the blockade as did all the others. But the *Porter* was then assigned as a dispatch boat to the *New York,* and the *Dupont* soon returned to Key West, where she was held in reserve by the station ship for dispatches. The *Dupont* made two long trips, accompanying a squadron to Cienfuegos, and going out to meet the *New York* on another occasion. She was also at Guantanamo at the end of the war. Her record for steaming during the war was about 9,000 miles.

The record for staunchness, sea-keeping power, and general excellence belongs to the *Porter,* which held the record of 12,900 miles of war service, on dispatch and blockade duty, without other repairs than those made by the force on board. About the 20th of July she went north for general repairs, and a complete overhauling, her boilers having reached their limit of endurance.

Thirdly.—Strategical and tactical demands.

The West Indies has ever furnished a battle-field for naval wars; and so will it be in our next war. The importance of being able to control its waters will be doubly accentuated by the need of controlling the Nicaragua Canal.

Destroyers.—The fleet of battleships must be maintained in these waters, and their safety from torpedo attack by the enemy must be insured by the destroyers. So that a flotilla of these in the proportion of two for each battleship would be a fair allowance. They must possess the speed sufficient to catch a 25-knot torpedo boat, and the sea endurance to remain with the fleet without being a constant source of anxiety to the commander-in-chief. A small, but powerful battery, and comfortable quarters for the crew are the chief essentials. Two torpedoes furnish a sufficient armament to give all of the moral effect of the torpedo boat. Moreover, two torpedoes carefully fired, would be as good as half a dozen.

Sea-Keeping Torpedo Boat. In addition to this flotilla of destroyers associated with the fleet of battleships, the commander-in-chief needs an offensive weapon that can be used against the hostile squadron which may be operating in some portion of the West Indies, or is making a feint at some point along the coast. This may be only a detached squadron; yet something must be done to meet it.

Twenty sea-keeping torpedo boats such as the *Porter* can be made to cover long distances at good speed, without being seen; make an attack and disappear, leaving the enemy in such a demoralized state that they will fall back on their base, or at least withdraw from that vicinity. Their employment as mounted infantry

and light artillery combined would, in the hands of an energetic commander-in-chief, be most demoralizing.

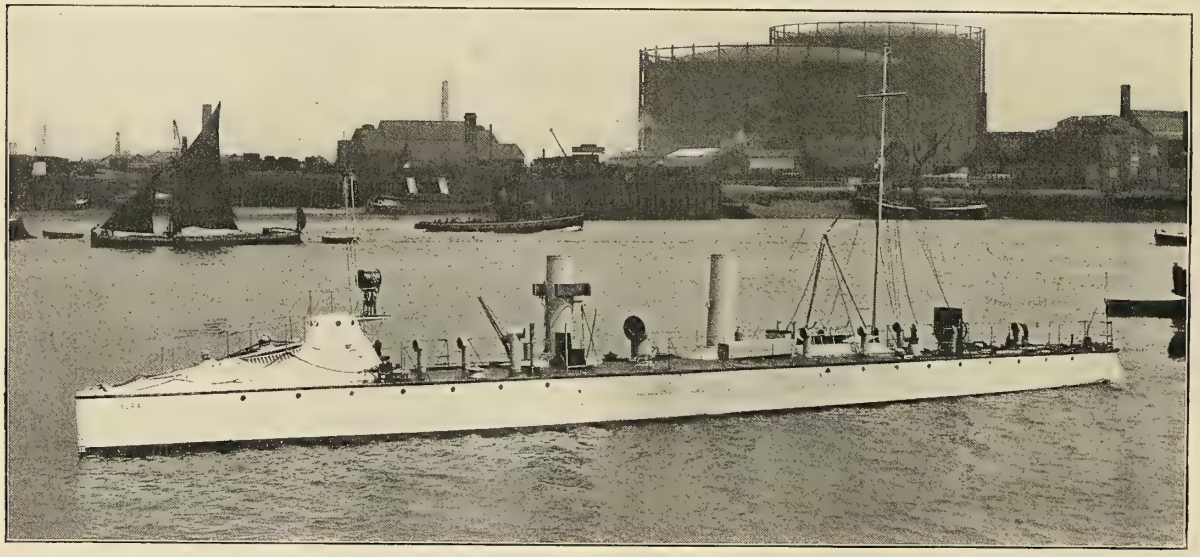
Station Boats.—Turning next to boats of limited endurance, which should be classified as station boats, they can be tactically classified under two heads. (*a*) Sea-going, capable of continuously operating for two or three days at a moderate distance from the base. To this class belong the *Cushing, Ericsson, Morris,* and even the *Winslow.* They are capable of selecting any point on the coast as a base, and can be rapidly mobilized at such point if scattered along our entire coast line of a thousand miles.

(*b*) Station boats whose operations are practically limited to a single night's attack, designed as a part of the coast defense system, operating through the inland waterways from Lake Erie and Buzzards Bay to Fernandina, Fla. Boats of this class are the *Talbot* and the *McKenzie,* the *Cushing* being almost too large for such work. The number of these boats required should be sufficient for the defense of Massachusetts Bay, Narragansett Bay, New York Bay, Delaware Bay, Charleston, Galveston, San Francisco Bay, and Puget Sound. A pair of these boats at each of these points would give a certain feeling of protection to the people, and liberate more valuable and powerful vessels for offensive operations. With the ten monitors now complete or building, distributed at these same points, the Secretary of the Navy would be able to give a satisfactory answer to the clamor for local protection. In the case of imminent danger at any point on the coast, this force could be concentrated to resist such attack, though this movement could not be rapidly effected. We have already the ten monitors which are especially fitted for this rôle; and the cost of sixteen more *Talbots* would be about one-fourth the price of one battleship.

The old Cunarders *Cephalonia* and *Pavonia,* on the Boston-Liverpool route, have been sold out of the service, the former to a Russian and the latter to an Italian ship owner.

Dutch Torpedo Boat Hydra.

In the engraving there is shown a view of the torpedo boat *Hydra* recently completed by Messrs. Yarrow & Co. for the Dutch Government. The *Hydra* is one of two similar boats, the other being the *Scylla.* They are intended to strengthen the naval power of the Dutch authorities in their East Indian colonies. The boats are 130 ft. long, 13 ft. 6 in. beam, and have a displacement of about 90 tons. The contract speed is 23 knots. The machinery consists of a set of triple expansion engines designed to indicate 1,200 horse power. The special feature of these engines, and in which they differ from those of other torpedo boats, is the system of forced lubrication which has been adopted, the working parts of the engine being completely enclosed. This plan has been introduced with great success in many types of land engines, and is becoming a feature of modern high speed engines in small sizes. The great advantage of forced lubrication is that all anxiety on the part of the engineering staff is set at rest as regards this the most important point in the proper working of such fast running machinery. The auxiliaries include a centrifugal circulating pump with its engine for supplying the condenser with water, an evaporator and distilling plant in duplicate; steam steering engine and air compressor; dynamo for electric lighting; an overhead fan and fan engine in the stokehold between the two boilers for forced draft; also a Worthington pumping engine in the stokehold for feeding the boilers when the main engines are not working. The bunkers hold about 18 tons of coal. The armament consists of three 18-in. swivel torpedo tubes, and two 6-pounder quick firing guns.



YARROW BUILT DUTCH TORPEDO BOAT HYDRA, 90 TONS DISPLACEMENT, SPEED 23 KNOTS.

The official trial of the *Hydra* took place on May 25. A mean speed of 24.37 knots was made for the three hours with 160 lb. of steam, and a trifle over 400 revolutions per minute, the load carried being 17 1-2 tons.

The official trial of the *Scylla* took place on June 26, with practically the same results.

BRITISH CENTRAL BATTERY IRONCLAD BELLEISLE BEFORE THE GUNNERY EXPERIMENTS.—SEE PAGE 422.

BRITISH IRONCLAD BELLEISLE AFTER BEING SHELLED BY H. M. S. MAJESTIC FOR NINE MINUTES.

Both these vessels have since had a full speed trial to show their capabilities when burning astatki, by means of Holden's spraying apparatus with which the vessels are fitted. It has been shown by these trials that there is no difficulty in burning this oil, and as it is plentiful in the Dutch East Indies there is no doubt it will be found an important adjunct to coal.

H. M. S. Belleisle Gunnery Experiments.

In a previous issue we described the results of the naval gunnery experiments carried out by the British Navy in which the first class battleship *Majestic* fired all her batteries at the old war vessel *Belleisle* for several minutes, and converted the upper works of the latter into a scrap pile. We now present original photographs (delayed in transmission) showing the *Belleisle* "before and after" the attack. After the attack the *Belleisle* sank on the sand bank over which she had been moored, but this is understood to have been caused by the amount of water pumped into her by the Admiralty tugs to extinguish fires rather than to the effect of shot in the vicinity of the water line. After the *Belleisle* had been pumped dry she was towed to dockyard for repairs. There have been practically completed and further use of the old ship as a target is to be made. On this occasion we are informed greater precautions to insure secrecy as to the result are to be made, and the attack will probably be delivered in some land locked waters on the British coast.

Superimposed Battleship Turrets.

In the preparation of the designs for the five new battleships for our Navy, plans for which will be ready for distribution among prospective bidders on the fifteenth of this month, a compromise was reached by the Naval Board as to the adoption of the superimposed turret. On three of the new battleships tandem turrets will be fitted with 12-in. guns in the lower and 8 in. guns in the upper turrets. On the other two battleships the 12 in. guns and 8 in. guns will be placed in entirely independent turrets in the usual manner. The general appearance of a vessel with tandem turrets is familiar to our readers, but to give a more detailed view we here reproduce a photograph showing the stern of the U. S. S. *Kentucky*. In this the position of the after guns of the main battery with relation to each other, and to the ship as a whole, is easily grasped. Both the *Kearsarge* and *Kentucky*, which are fitted with tandem turrets, can throw a weight of heavy battery fire of 2,700 lbs. astern at each discharge.

New Ore Dock.—What is claimed to be the largest iron ore shipping dock ever built and the largest piece of timber construction in the world has just been completed at the head of Lake Superior for the Eastern Minnesota Railway Co. The deck of the new structure which has to stand the strain of trains carrying 1,200 tons and upwards rises 73.1 ft. above water, the hinge of the ore spout being 40 ft. above water. The dock is 1,500 ft. long, 65 ft. wide and contains 250 ore pockets, each estimated to contain 260 gross tons of ore. The capacity of the dock is 65,000 tons, and all this may be loaded into ships in thirty-six hours.

CHANGES IN VESSEL CONSTRUCTION IN FORTY YEARS OF LLOYD'S REGISTER.*

BY B. MARTELL.

In this paper I propose to give a brief summary of the changes and developments in the construction of ships for the Mercantile Marine during the last forty years.

At the commencement of this period wood was still the principal material employed for shipbuilding, and although iron had been introduced for general ship-building purposes some twenty years earlier, the record of new tonnage added to the British Register in 1860 shows only about 30 per cent. to have been built of iron.

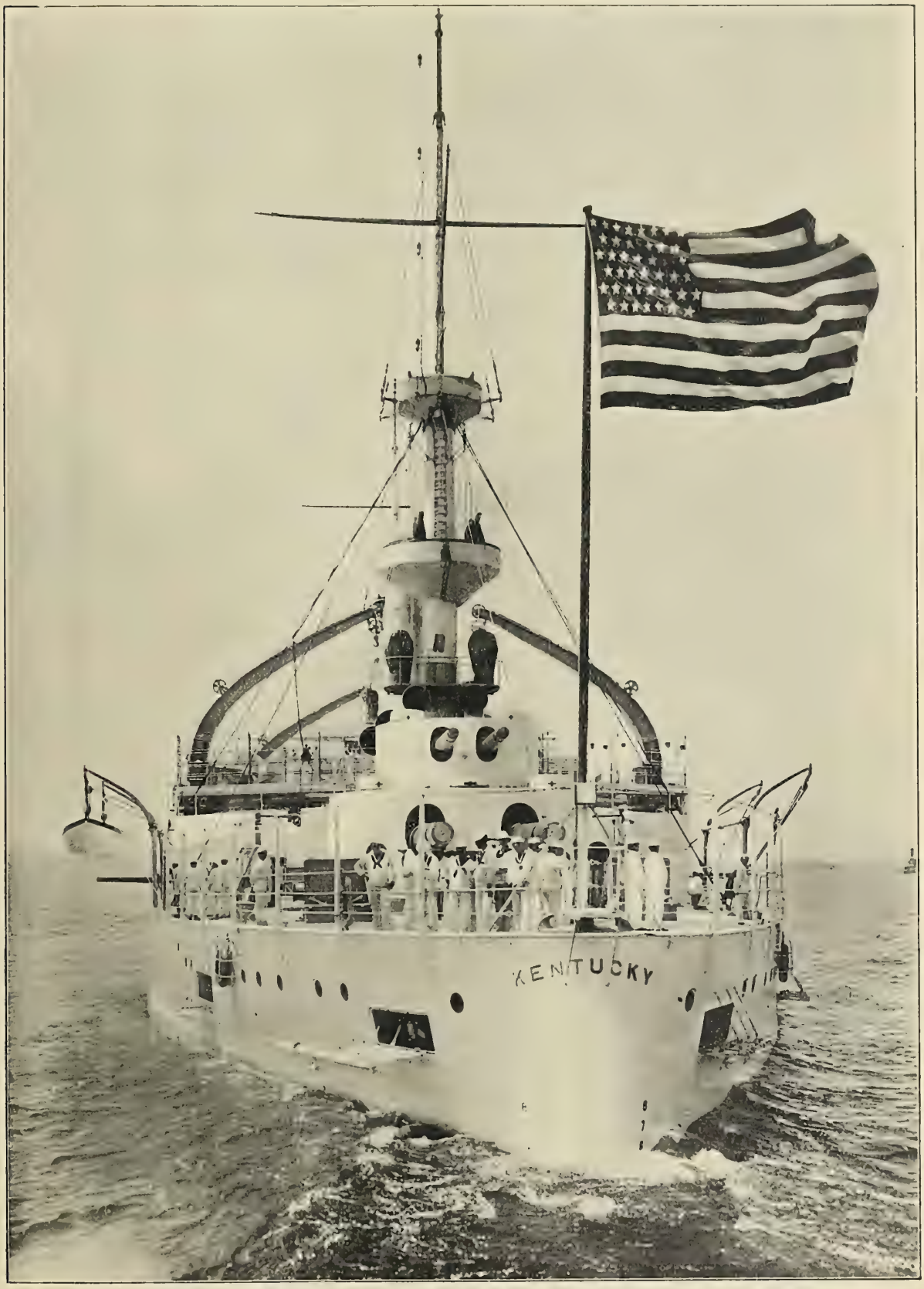
On the Wear, with which district I was early associated, 112 vessels were built in 1860, nearly all of wood, the average tonnage being 359 tons. Some wood vessels of considerable size had been built there, amongst which may be mentioned the *Duncan Dunbar*, of 1,374 tons, and 229 ft. in length, but such vessels were comparatively few. In the larger wood vessels, it had become the practice to fit iron diagonal plates outside the frames, but the practical difficulties of producing a sufficiently strong structure with ships built of wood, prevented that increase of size which has been rendered possible by the introduction of iron and steel.

It is well known that when iron was first introduced, there existed a great deal of doubt as to its suitability for shipbuilding purposes. The stranding of the iron steamer *Great Britain*, the largest vessel of her time, in Dundrum Bay, on the coast of Ireland, in September, 1846, where she was exposed to storms during several months of the winter, and was afterwards found to have sustained but little injury, tended, however, to establish confidence in iron. After visiting this vessel, and witnessing the great endurance of iron compared with wood ships, Sir James (then Mr.) Laing resolved to commence building iron ships, and it is to his initiative that the extension of iron shipbuilding on the Wear is largely due. In the year 1853 he launched his first iron ship, the *Amity*, and in 1866 discontinued the building of wood vessels.

The general adoption of iron for shipbuilding on the Wear dates from about the year 1863, and by 1880 it had, in that district, entirely taken the place of wood. On the Clyde, Mersey, and Tyne, iron shipbuilding was adopted at an even earlier date. So far back as 1855 iron had largely taken the place of wood for shipbuilding on the Clyde.

The first Rules for the construction of iron ships were published by Lloyd's Register in 1855, and provided for the classification of iron vessels for a term of years in the same manner as wooden ships. In those Rules the scantlings of the framing and plating were given for vessels of from 100 to 3,000 tons gross register, and the frame spacing was required to be 16 in. for vessels of the 12 years' grade, and 18 in. for those of the 9 and 6 years' grade.

*Read before the Institution of Naval Architects, London.



Photograph Copyright 1900, by Mueller, Brooklyn.

STERN VIEW OF U. S. BATTLESHIP KENTUCKY, SHOWING SUPERIMPOSED TURRETS —SEE PAGE 422.

These Rules are interesting as showing, in the transition from wood to iron, how the ideas and practice relating to wood shipbuilding found expression in the close spacing of frames and distribution of material adopted in the early iron vessels.

In 1863 the Rules of Lloyd's Register for the building of iron ships were revised as the result of growing experience, and new symbols of classification, $\frac{A}{A}$, $\frac{A}{B}$ and $\frac{A}{C}$, were introduced. The first two denoted those vessels which had been built in accordance with, or equal to, the Rule requirements, and the class $\frac{A}{C}$ denoted those vessels which, although not built in accordance with the Rules, were considered entitled to that class.

In those rules the scantlings were given for vessels of from 100 tons to 3,500 tons, and the frame spacing was increased to 21 in., but in vessels having double frames for half length amidships, the frame spacing could be extended to 23 in. for vessels under 1,000 tons, and to 24 in. for vessels of 1,000 tons and upwards.

The difficulty of preventing the fouling of the bottoms of iron ships due to corrosion or marine growths, and the consequent loss of speed, led to various attempts being made to sheath the bottoms of iron ships and cover the wood sheathing with copper, yellow metal, or zinc sheets. The result was the introduction of the system of construction known as "Composite," in which the framing was of iron, with wood planking wrought on the iron frames, and sheathed with copper or yellow metal.

The earliest vessel of this construction was the *Tubal Cain*, of 787 tons, built at Liverpool in 1851. It may be interesting to notice here the construction of that vessel. The iron frames were spaced 18 inches apart, and the outside plank was fastened to the frames with nut and screw bolts, the heads being sunk into the planks and the holes filled with composition. The planks were also bolted edgeways from keel to gunwale. The planking was then sheathed with 1 1-2 in. yellow pine over felt. This wood sheathing was again covered with felt and then copper sheets.

Another of these vessels was the *Gossamer*, of 735 tons, built at Glasgow in 1864, and which had worked outside the frames, an iron sheerstrake and a strake of plating below the hold beam stringer plate, with diagonal plates along the sides above this strake. This ship was wrecked off Prawle Point, and the upper portion was found to have parted from the lower, at about the line of the hold beams, and to have been removed to some distance from the lower portion. After this experience, the diagonal plates were required to be extended from the sheerstrake to the bilge in vessels of composite construction.

In 1864, the *Dilpussund*, of 624 tons, and in 1865, the *Dilbhur*, of 1,308 tons were built in London by C. Lungley. The method of construction was known as Lungley's Patent. Two thicknesses of outside planking were fitted, having iron diagonal plates worked between. The inner thickness was fastened to the iron frames with galvanized iron bolts; iron diagonal plates were then fitted outside the inner planking; the outer thickness of planking was secured to the inner by yellow metal bolts, and the outer thickness then sheathed with yellow metal.

The early composite ships were classed as experimental, and subject to biennial survey, in order that the condition of the fastenings might be examined, and the effects of the galvanic action set up by the iron framing and yellow metal sheathing ascertained from time to time.

In 1867 Lloyd's Register issued suggested Rules for the Construction of Composite Ships. These Rules required iron sheerstrakes and bilge plates to be fitted, and diagonal plates outside the frames, and one thickness of planking, with a uniform frame spacing of 18 in. for all sizes.

The *Sir Lancelot*, 886 tons, built at Greenock in 1865, and the *Thermopylæ*, 990 tons, built at Aberdeen in 1868, which were amongst the most famous of the China tea clippers, were constructed in this manner.

With the opening of the Suez Canal, and the general introduction of steam, the demand for these composite ships ceased, and, except for yachts the composite system of construction for merchant vessels is a thing of the past.

In 1870 the Rules of Lloyd's Register were entirely revised, and instead of the scantlings being regulated by the tonnage of the vessels, they were so arranged as to be regulated by numerals obtained from the principal dimensions. With these Rules new symbols of classification, 100A, 90A and 80A, were introduced. This system remains in use to the present time, and has been found by experience to work satisfactorily.

So far back as 1862, applications were made for vessels to be classed which were to be built with puddled steel, but in the absence of experience regarding the durability of steel, the Committee of Lloyd's Register felt it was not in their power to sanction the proposal.

In 1864, however, a steam yacht of 2,400 tons was built for the Viceroy of Egypt under the survey of Lloyd's Register Surveyors, and constructed partly of steel. A reduction of about one-fourth was allowed in the steel scantlings from those required for an iron ship of the same size.

In 1866 proposals to build a vessel of 1,552 tons with Barrow hematite steel, with about two-thirds the sectional area of scantlings required for iron, were approved on certain conditions for classification, with the notation "Experimental." In the year following, consequent upon a report upon the steel manufactured at Barrow-in-Furness by the Bessemer process, Lloyd's Register Committee decided to class ships built, under special survey, of steel of approved quality, with the notation "Experimental." A reduction in scantlings was allowed not exceeding 25 per cent. of the thicknesses prescribed for iron ships, and the steel was required to have a tensile strength of not less than 30 tons per sq. in.

After this, the question of the suitability of steel for shipbuilding remained in abeyance for several years.

In April, 1876, James Riley, then manager, of the

Siemens Steel Works at Landore, read a paper before this institution on the production of mild steel, setting forth the results of experiments that had been made with steel manufactured by the Siemens-Martin or open hearth process, and showing the qualities of this material as to ductility and tensile strength.

These results were placed before the Committee of Lloyd's Register, and in 1877, plans from John Elder & Co. were approved for the construction of two paddle steamers to be built of this material for the English Channel service, with a reduction of about 20 per cent. in the scantlings which had been adopted for iron vessels.

In the same year, in consequence of a report, which may be found in the volume of Transactions of this Institution for 1877, it was decided to admit steel with scantlings 20 per cent. lighter than prescribed for iron, in vessels building for classification, subject to the material having a tensile strength of from 26 to 30 tons per sq. in., and an elongation of 20 per cent. on a length of 8 in. These limits of tensile strength have since been raised to 28 to 32 tons.

In the paper which I had the honor to read before this Institution in April, 1886, a brief review was given of the progress of mild steel for shipbuilding purposes. It was shown that while in 1878 seven steel vessels, of 4,470 tons, were classed in Lloyd's Register, and 435 iron vessels, of 517,692 tons, the record for the year 1885 showed 118 steel vessels, of 165,437 tons, as compared with 260 iron vessels, of 290,429 tons. As wood was superseded by iron as a material for shipbuilding, so in its turn iron has given place to steel.

Of the total output of the United Kingdom during the past year, 98.8 per cent. of the tonnage was built of steel, and 1.1 per cent. of iron. The iron tonnage was principally made up of trawlers, and comprised no vessel of more than 303 tons.

The following Tables A and B show the relative changes in the number and tonnage of British steamers and sailing vessels of wood, composite, iron, and steel respectively during recent years.

Soon after the introduction of mild steel for shipbuilding purposes, attention was given to the making of heavy steel castings to take the place of iron forgings for stern frames, rudders, propeller brackets, stems, quadrant tillers, etc. These castings are required to be subjected to certain tests, and at the present time are often adopted in place of iron forgings.

It may be here remarked that, notwithstanding the early doubts as to the durability of steel, experience has shown that where proper care is taken to thoroughly clean and paint the surfaces, the deterioration is not appreciably greater than that of iron. In some parts, however, such as thin deck plating, and plating of inner bottom and floors under boilers, steel appears to be more liable to deteriorate, and in consequence of this, iron is often used for these parts, in vessels otherwise constructed of steel.

Having thus outlined the change from wood to iron, and from iron to steel, I will now refer to the great increase in the size of vessels which has taken place in the period under review.

In 1860 the average size of iron steamers built and registered in the United Kingdom was 340 tons; in 1870 it was 580 tons; in 1880 for iron and steel steamers it had become 1,250 tons; in 1890 it had increased to 1,580 tons; and in 1899 it was 1,940 tons.

As regards iron and steel sailing vessels, the average sizes show first an increase and then a great diminution.

In 1860 the average size was 425 tons, in 1870 it was 775 tons, in 1880 it had become 970 tons, in 1890 it had increased to 1,570 tons, and in 1899 it had fallen to 190 tons.

TABLE A.

TABLE SHOWING THE NUMBER, TONNAGE, AND DESCRIPTION OF BRITISH STEAMERS OF 100 TONS GROSS AND UPWARDS, AS RECORDED IN LLOYD'S REGISTER BOOK.

Year.	Wood.		Composite.		Iron.		Steel.		Total.	
	No.	Tons (Gross).	No.	Tons (Gross).	No.	Tons (Gross).	No.	Tons (Gross).	No.	Tons (Gross).
1886	139	26,051	1	179	4,511	5,455,935	369	679,942	5,020	6,162,117
1889	115	20,059	4	1,750	4,092	5,108,561	921	1,759,806	5,132	6,890,176
1894	114	18,772	6	2,168	3,679	4,140,245	2,523	5,146,598	6,322	9,307,783
1899	115	19,474	7	2,491	2,911	2,633,093	3,887	8,431,183	6,920	11,086,241

TABLE B.

TABLE SHOWING THE NUMBER, TONNAGE, AND DESCRIPTION OF BRITISH SAILING VESSELS OF 100 TONS NET AND UPWARDS, AS RECORDED IN LLOYD'S REGISTER BOOK.

Year.	Wood.		Composite.		Iron.		Steel.		Total.	
	No.	Tons (Net).	No.	Tons (Net).	No.	Tons (Net).	No.	Tons (Net).	No.	Tons (Net).
1886	3,328	946,937	119	90,600	1,607	2,132,037	60	79,233	5,114	3,248,807
1889	2,052	552,762	81	58,910	1,505	1,731,100	150	192,235	3,798	2,535,007
1894	1,214	262,652	35	23,312	1,204	1,390,071	486	823,192	2,939	2,499,227
1899	798	147,798	13	5,965	749	902,349	493	784,571	2,053	1,840,683

These averages are, of course, considerably affected by the inclusion of a large number of small vessels. A better idea of the growth will be obtained from the following figures, published in Lloyd's Register Statistical Tables for 1899, showing the average size of vessels classed during the last ten years, and excluding all under 200 tons, in order to avoid the diminution caused by yachts, trawlers, etc.

The following table shows the number, tonnage and description of all vessels of 100 tons and upwards, built in the United Kingdom and still in existence, as recorded in Lloyd's Register Book for 1899.

TABLE C.

COMPARATIVE AVERAGE TONNAGE FROM 1890 TO 1899.

	1899.	1898.	1897.	1896.	1895.	1894.	1893.	1892.	1891.	1890.
Steam	2,807	2,634	2,452	2,555	2,647	2,219	2,356	2,212	2,100	1,971
Sail	1,612	1,441	1,741	1,826	1,607	1,816	1,684	1,889	1,696	1,783

TABLE D.

TABLE SHOWING NUMBER, TONNAGE, AND DESCRIPTION OF ALL VESSELS OF 100 TONS AND UPWARDS, BUILT IN THE UNITED KINGDOM AND STILL IN EXISTENCE, AS RECORDED IN LLOYD'S REGISTER BOOK FOR THE YEAR 1899.

STEAMERS.

Material.	Under 200 Tons.	200 to 399 Tons.	400 to 599 Tons.	600 to 799 Tons.	800 to 999 Tons.	1,000 to 1,499 Tons.	1,500 to 1,999 Tons.	2,000 to 2,999 Tons.	3,000 to 3,999 Tons.	4,000 to 4,999 Tons.	5,000 to 6,999 Tons.	7,000 to 9,999 Tons.	10,000 Tons and Above.	Total.
Wood	127	13	14	2	...	1	...	...	...	...	...	...	...	157
Composite	7	6	5	3	3	...	...	...	...	...	...	...	...	24
Iron	1,243	600	355	389	348	790	649	445	135	42	13	2	...	5,011
Steel	671	465	323	237	214	496	514	1,360	816	283	233	51	15	5,678
Total	2,048	1,084	697	631	565	1,287	1,163	1,805	951	325	246	53	15	10,870

SAILING VESSELS.

Material.	Under 200 Tons.	200 to 399 Tons.	400 to 599 Tons.	600 to 799 Tons.	800 to 999 Tons.	1,000 to 1,499 Tons.	1,500 to 1,999 Tons.	2,000 to 2,999 Tons.	3,000 to 3,999 Tons.	Total.
Wood	619	280	75	25	13	10	...	...	...	1,022
Composite	4	4	18	10	17	8	...	...	...	61
Iron	54	81	126	172	156	417	226	65	3	1,300
Steel	23	42	27	27	22	134	203	170	4	652
Total	700	407	246	234	208	569	429	235	7	3,035

I have also appended to this paper a table (see Table F) showing the number, tonnage and description of vessels built and registered in the United Kingdom for the years 1860 and 1870, and for each year since 1880, in order to illustrate the great increase which has taken place in the Mercantile Marine of this country, and a diagram showing the variation in the tonnage of iron and steel steam and sailing vessels during the past twenty years.

The size of vessels launched during 1899, and also those under construction in the United Kingdom at the end of 1899, arranged according to gross tonnage, is shown in Table E on page 427.

The largest steamers which have been launched in the United Kingdom during the past year are the following:

	Tons Gross.		Tons Gross.
Oceanic	17,274	Saxon	12,970
Ivernia	13,900	Saxonia	12,750
Minneapolis	13,750	Persic	11,973

Germany has launched the *Patricia*, of 13,293 tons, and the *Grosser Kurfurst*, of 12,500 tons, besides six other steamers of 10,000 tons and over.

The figures I have given show very clearly the change which has taken place in the relative number of steam and sailing vessels.

In 1889, 10 per cent of the output was composed of sailing tonnage. For the four following years (1890 to 1893), the proportion rose to 19 per cent. Since that period the construction of sailing vessels has rapidly declined, until in 1899 sailing tonnage formed less than 0.14 per cent of the output.

In France, however, the construction of large sailing vessels, almost abandoned elsewhere, has continued to flourish under the influence of the bounties granted by the state. Twenty-four such vessels, of 2,000 tons and upwards, were launched during 1899. The largest of these, and likewise the largest seagoing sailing vessels built in the world during the past year, are the *Ville de Mulhouse* and the *Ville du Havre*, each of 3,214 tons.

The progress and change as regards types of vessels have been no less remarkable than the development in size and material of construction.

In July, 1891, I had the honor to read before this

Institution a paper dealing with the alterations in the types and proportions of mercantile vessels. In that paper it was shown how various types had been brought into existence as the result of experience, or to meet the exigencies of trade.

I need not now repeat the descriptions given therein of the types which had successively been introduced up to that period; but in continuation of that paper it may be remarked that, while "well-deck" steamers at that time formed so large a percentage of the number of ordinary cargo steamers, comparatively few are now being built, and these are principally intended for the coal trade, or are small vessels for the coasting trade.

TABLE E.

SIZE OF MERCHANT AND OTHER VESSELS (NOT WARSHIPS) LAUNCHED IN THE UNITED KINGDOM DURING 1899.

Tonnage.	Steam.	Sail.
*Under 50 tons	3	2
*50 to 99 tons	8	2
100 to 199 tons	205	5
200 to 499 tons	94	3
500 to 999 tons	39	..
1,000 to 1,999 tons	76	..
2,000 to 2,999 tons	57	..
3,000 to 3,999 tons	129	..
4,000 to 4,999 tons	39	..
5,000 to 5,999 tons	27	..
6,000 to 6,999 tons	15	..
7,000 to 7,999 tons	9	..
8,000 to 8,999 tons	..	..
9,000 to 9,999 tons	4	..
10,000 tons and above	9	..
Total	714	12

*Vessels of less than 100 tons are not included in these returns, unless they are intended to be classed in Lloyd's Register Book.

SIZE OF VESSELS UNDER CONSTRUCTION (WARSHIPS EXCLUDED) IN THE UNITED KINGDOM AT THE END OF THE YEAR 1899, CLASSIFIED ACCORDING TO GROSS TONNAGE.

Tonnage.	Steam.	Sail.
*Under 50 tons	..	7
*50 to 99 tons	4	2
100 to 199 tons	98	9
200 to 499 tons	83	9
500 to 999 tons	31	1
1,000 to 1,999 tons	53	3
2,000 to 2,999 tons	32	..
3,000 to 3,999 tons	78	..
4,000 to 4,999 tons	45	..
5,000 to 5,999 tons	35	..
6,000 to 6,999 tons	17	..
7,000 to 7,999 tons	7	..
8,000 to 8,999 tons	2	..
9,000 to 9,999 tons	6	..
10,000 tons and above	16	..
Total	507	31

*Vessels of less than 100 tons are not included in Lloyd's Register Shipbuilding Returns, unless they are intended to be classed in the Society's Register Book.

The partial awning-deck steamers, which, at the period referred to, were much in favor with ship owners, have also given place to other types, and but few are now being constructed, while those having a raised fore deck, which formed the subject of discussion on the paper referred to, have entirely gone out of fashion.

The tendency has been to revert to flush-deck vessels, having short poop, bridge-house and forecastle, as in the earlier type of steamer, but of much greater relative breadth to depth.

The deep narrow ships which were so commonly built in the seventies, and to which I drew the attention of this Institution in March, 1880, have long since ceased to be built. The erroneous impression that breadth was an insurmountable deterrent to speed was removed by the experiments by the late Mr. Froude, and, since public attention was directed to the large number of losses of badly proportioned steamers, due to insufficient stability, the relative proportion of breadth to depth has been greatly increased.

In 1879 the average relation of registered depth to breadth in vessels of the three-deck type was .69, in 1890 it had fallen to .62, and in 1899 it had still further fallen to .52.

A type of vessel which has been much in favor for certain trades during the past few years is the large single-deck steamer, having a tier of middle or lower deck beams, but no deck laid thereon. There is also a tendency to lengthen the bridge-house in steamers, and in some cases it has been extended over more than half the vessel's length amidships.

Another type of recent development is generally known as the "shelter-deck" steamer, having a continuous superstructure all fore and aft, with one or more "tonnage openings" in the deck. These vessels are constructed principally for the cattle trade, the space between the upper and shelter decks being fitted for that purpose. Some of the larger vessels of this type have a bridge-house of considerable length, built above the shelter deck for cabin accommodation.

The turret-deck steamers, introduced by Doxford & Sons, and the trunk-deck steamers introduced by Ropner & Sons, are so well known to the members of the Institution that I need only mention them as instances of new types created within the last decade.

The subject of water ballast is now occupying a great deal of attention, in consequence of the great increase in the breadth of ships, their comparatively light draught, and the fact that those vessels employed in the American trade mostly proceed to that country in ballast.

In the paper which I read before the members of this Institution in August, 1877, I described the early history of the subject, and the various systems of construction of double bottoms for carrying water ballast. At the present time very few steamers are built without a double bottom for water ballast. Either the cellular or McIntyre system of construction is adopted. Deep midship tanks, in addition to fore and after peak tanks, are now largely fitted, particularly in cargo steamers intended for the Atlantic trade.

One notable step in this direction is the construction of side tanks for a considerable portion of the length. The first of this kind was the *Mancunia*, built by Gray & Co., at West Hartlepool, in 1898, in which the side tanks have a capacity of upwards of 700 tons of water ballast, in addition to the ordinary cellular double bottom.

As regards changes in methods of construction, there may be mentioned the adoption of web frames in lieu of hold beams or lower deck beams. Some

vessels had been so built in the early seventies, but it was not until about 1886 that the system became general, and in 1888 Lloyd's Register issued definite rules for the same, as the result of the experience gained up to that time. Not long after, deep framing, or, as it is sometimes termed, girder framing, came into use. It has since been largely adopted in place of web frames or hold beams, and rules for this system of framing were published by Lloyd's Register in 1895.

A few remarks may be made regarding the progress in the construction of vessels for carrying oil in bulk, a subject on which I read a paper before the members of this Institution at Liverpool, in 1886. At that time there were only about ten steamers specially adapted and engaged carrying oil in bulk on oversea voyages. The current issue of Lloyd's Register shows a list of 174 steamers and 15 sailing vessels carrying petroleum in bulk. Great improvements have been made in the construction of these vessels as the result of experience, and, as with other types of steamers, there has been a great increase in size.

Instead of vessels of about 1,500 tons as first employed in this trade, for oversea voyages the last additions to the fleet of steamers carrying oil in bulk are upwards of 6,000 tons gross register, and over 400 ft. in length.

The progress of marine engineering during the last forty years has been not less marked than that of shipbuilding. In fact, engineering and shipbuilding are so closely allied that everything that influences the one must have a marked effect upon the other. The enormous increase in the sizes of vessels to which I have alluded has only been rendered possible by the advances made in engineering practice, enabling immense power to be placed on board such vessel, with, at the same time, reasonable fuel expenditure. Forty years ago the engines in use were simple cylinders working with low boiler pressure.

In 1872 F. J. Bramwell (now Sir F. J. Bramwell) read a paper before the Institution of Mechanical Engineers at Liverpool on "The Progress Effected in Economy of Fuel in Steam Navigation Considered in Relation to the Compound Engine and High-pressure Steam." The paper was most exhaustive, and should be referred to now as a standard of what was then considered to be excellent practice. He showed that the coal consumption had been reduced from over 3 lb. of coal per indicated horse power per hour to little over 2 lb. The boiler pressures were then 45 lb. to 65 lb. per sq. in., and the average piston speed 376 ft. per min.

In 1881, F. C. Marshall, one of our distinguished marine engineers, and a Member of Council of this Institution, contributed another paper to the Institution of Mechanical Engineers at Newcastle, and he showed that at that time further progress had been made. The use of steel for boilers had enabled pressures of 90 and 100 lb. per sq. in. to be carried, and the higher pressures and improvements in the engines had reduced the coal consumption to 1.8 lb. per indicated horse power per hour. Piston speeds had increased to an average of 467 ft. per minute.

In 1887 the same gentleman read a paper before this Institution on the same subject, and showed that at that time 150 lb. pressure had become common, and that not only had pressures advanced, but the power of the engines had also been enormously increased, the *Umbria* and *Etruria* being instanced as indicating over 14,000 I. H. P. at sea, with a piston speed of 900 ft. per minute. At the same time the consumption of fuel had been reduced to 1.5 lb. per indicated horse power per hour.

At the present time still further advances have been made, 200 lb. per sq. in. is an everyday pressure with some of our largest steamers, and a few are working with still higher pressures—as high as 260 lb. having been reached with ordinary boilers—and the tendency is for further advancement to be made. A corresponding economy of fuel has resulted from the increased pressure, and, if the ideal 1 lb. of coal per indicated horse power per hour has not been actually reached,[1] some of our marine engineers are sanguine that this marvelous result will shortly be achieved. The powers of the engines have also advanced, culminating at present in the *Oceanic*.[2]

In conclusion, I will briefly refer to the load line question, which has occupied so prominent a position during the period under review.

The first step which led up to the present system of supervising the loading of ships was taken in 1869, when a bill was introduced into Parliament containing a clause requiring the draught of water at which vessels leave port to be recorded.

The bill failed to pass, but in 1870 the Merchant Shipping Code Bill was introduced, containing the same provision, and also requiring a scale showing the draught of water to be marked on the stem and stern post of every British ship. These requirements passed into law in 1871, and the same Act also empowered the Board of Trade to appoint persons to record the draught of water of all seagoing ships upon leaving port.

In March, 1873, the Government appointed a Royal Commission on Unseaworthy Ships, and one of the questions considered was that of the load line.

In their final report, issued in 1874, the Commission arrived at the conclusion that a settlement of a load line should be mainly guided by the consideration of reserve buoyancy; but they held it to be impossible to prescribe any universal rule for the safe loading of merchant ships, and were of opinion that an Act of Parliament enforcing any scale of freeboard would be mischievous.

In March, 1874, I read before this Institution a paper on this subject, and with the paper included tables of freeboard based upon the principle of reserve buoyancy.

These tables had been prepared from data collected from all the principal ports of the United Kingdom, relating to the loading of the various types of vessels then in existence.

[1] This result has been achieved in the case of the S.S. *Kensington* and, we believe, in the case of the S.S. *Inchmona* also.—Ed. M. E.

[2] The author appears to be under a misapprehension here, as the *Oceanic* has developed less horse power than other vessels in the Atlantic trade which preceded her, and has about 7,000 I H.P. less than the *Deutschland*.—Ed. M. E.

It was then proposed for the first time to use a tonnage co-efficient of fineness as an indication of the form, in order to adapt the principle upon which the Tables were based to the many thousands of vessels afloat, without the necessity of calculating the displacement from the drawings, or of placing the vessel in dry dock for the purpose of obtaining the form.

In 1875, a short bill, to remain in force only till October of the following year, was passed, containing provisions requiring all British ships to have the position of their decks marked upon the sides, and every *foreign-going* British ship was also required to have a circular disc marked upon the sides, indicating the maximum draught to which the owner claimed to load.

TABLE SHOWING THE NUMBER, TONNAGE, AND DESCRIPTION OF VESSELS BUILT AND REGISTERED IN THE UNITED KINGDOM.

		Steel.		Iron.		Wood and Composite.		Total.	
		No.	Tons (Gross).	No.	Tons (Gross).	No.	Tons (Gross).	No.	Tons (Gross).
1860	Steam	—	—	149	51,115	49	2,681	198	53,796
	Sail	—	—	32	13,584	786	144,588	818	158.172
1870	Steam	—	—	382	222,922	51	2,752	433	225,674
	Sail	—	—	63	48,838	478	68,194	541	117,032
1880	Steam	26	36,493	362	447,389	20	1,779	408	485,661
	Sail	4	1,671	39	40,015	273	18,159	316	59,845
1881	Steam	34	68,366	411	590,503	30	1,659	475	660,528
	Sail	3	3,167	50	68,650	259	16,448	312	88,265
1882	Steam	65	115,449	446	672,740	30	1,784	541	789,973
	Sail	8	12,478	83	112,852	246	13,066	337	138,396
1883	Steam	92	141,552	548	742,292	30	1,651	670	885,495
	Sail	11	14,193	72	114,698	229	13,551	312	142,442
1884	Steam	67	108,978	413	456,982	38	2,364	518	568,324
	Sail	9	13,360	93	130,017	277	17,142	379	160,519
1885	Steam	122	154,249	177	148,508	37	2,751	336	305,508
	Sail	27	30,569	144	160,034	266	17,841	437	208,444
1886	Steam	124	160,973	119	82,201	30	1,467	149	244,641
	Sail	31	30,588	55	97,713	226	14,266	281	142,567
1887	Steam	196	326,530	66	40,070	24	1,097	90	367,697
	Sail	29	25,994	27	44,979	170	8,782	197	79,755
1888	Steam	321	571,437	87	31,697	23	2,370	110	605,504
	Sail	33	42,666	13	18,882	177	8,686	190	70,234
1889	Steam	411	783,193	97	46,402	25	1,368	533	830,963
	Sail	47	90,469	11	12,385	157	8,256	215	111,110
1890	Steam	432	817,010	110	40,144	26	1,326	568	858,480
	Sail	59	96,374	6	5,911	142	7,704	207	109,989
1891	Steam	388	730,051	167	31,381	25	1,212	580	762,644
	Sail	93	178,593	3	1,544	156	8,541	252	188,678
1892	Steam	365	660,847	86	18,937	19	1,026	470	680,810
	Sail	128	260,874	6	5,121	151	8,372	285	274,367
1893	Steam	328	622,099	64	12,458	27	1,551	419	636,108
	Sail	66	113,097	4	418	154	7,980	224	121,495
1894	Steam	389	751,668	65	12,400	26	1,183	480	765,251
	Sail	67	83,167	3	207	155	7,570	225	90,944
1895	Steam	379	736,412	66	9,897	35	1,579	480	747,888
	Sail	32	41,313	9	782	150	7,529	191	49,624
1896	Steam	398	750,106	79	11,593	17	591	494	762.290
	Sail	36	37,709	5	792	161	7,519	202	46,020
1897	Steam	366	658,646	63	9,974	33	1,581	462	670,201
	Sail	34	28,481	2	232	183	8,317	219	37,030
1898	Steam	546	996,814	80	13,654	20	765	646	1,011,233
	Sail	40	8,456	6	798	196	8,813	242	18,067
1899	Steam	534	1,152,999	64	12,184	29	1,497	627	1,166,680
	Sail	60	11,757	2	182	165	7,342	227	19,281

These provisions were confirmed by a larger Act passed in 1876, which extended the compulsory marking of disc and deck lines to *all* British ships, except those under 80 tons, engaged exclusively in coasting and those employed in fishing, and pleasure yachts. Prior to the passing of the Act of 1876, a Committee had been appointed by the Board of Trade to consider the possibility of framing rules for regulating freeboard. This Committee comprised representatives of the Board of Trade, Lloyd's Register, and the Liverpool Underwriters' Registry, but the attempt to establish an authorized scale of freeboard failed.

The subject of freeboard, however, continued to occupy a great deal of attention on the part of Lloyd's Register, and the investigations necessary for arriving at a settlement of the question and the collection of all available data were carried on by the Society's officers for several years.

The result was that in August, 1882, the Committee of Lloyd's Register issued the first authoritative Tables of Freeboard, and undertook to assign freeboards on the basis of those tables where the owners made application for the same. During the time these tables were in use, a period of about three years, freeboards were assigned to 944 vessels, and in the case of 775 of this number, the freeboards were voluntarily accepted by the owners and marked upon the vessels' sides.

In December, 1883, the Board of Trade appointed the Load Line Committee, and in 1885, after prolonged labor and investigation, that Committee presented its report. The Load Line Committee's Tables, which agree closely with the tables previously issued by the Committee of Lloyd's Register, were adopted by Lloyd's Committee, in September, 1885.

Between that time and June, 1890, when the Load Line Act was passed, freeboards were assigned by Lloyd's Register, on the application of owners, to 2,850 steam and sailing vessels, and these freeboards were adopted in 2,520 cases.

Since the passing of the Load Line Act, some modifications have been made in the application of the Freeboard Tables to meet the development of new types and methods of construction, and the regulations have been revised on the recommendation of committees appointed by the Board of Trade, and representing the various assigning authorities, in the years 1892, 1894 and 1898.

In the last-named year, the freeboard required for winter North Atlantic voyages was revised, and the tables of freeboard were extended to provide for vessels of much greater size than included in the original tables.

A Five-Thousand-Ton Wooden Schooner.

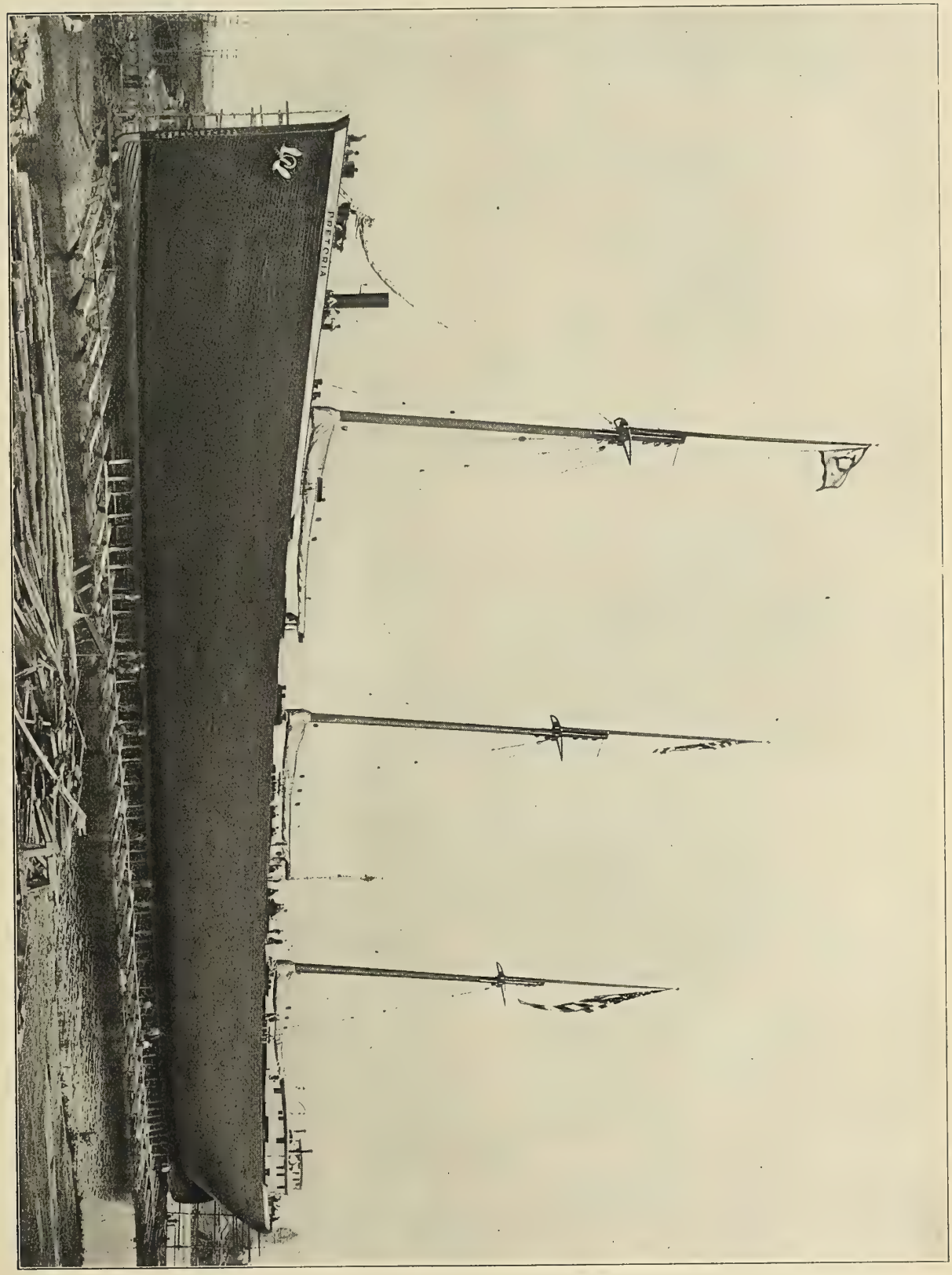
Although steel has superseded wood to a very great extent as a material for the construction of large modern vessels, yet on both the coasts and lakes wood construction is not by any means a lost art. We show in the accompanying reproduction a photograph of what is believed to be the largest wooden sailing vessel ever built. This is the *Pretoria*, built and owned by James Davidson, of Bay City, Mich. The photograph was taken a few minutes before the vessel was launched from his yard. Her dimensions are: Length of keel, 335 ft.; length over all, 350 ft.; beam, 45 1-2 ft.; depth moulded, 27 ft.; depth of hold in shoalest place, 23 ft.; carrying capacity 5,000 gross tons on 18 ft. 6 in. draft; light draft, 6 ft., forward and 6 ft. aft. The *Pretoria* was launched July 26, last.

The *Pretoria* has eleven hatches, and they are all spaced 24 ft. centers. This schooner is built entirely of Michigan white oak, and her frames are moulded 16 in. at the throat, 14 in. at the bilge and 7 in. at the top. The main kelson is 18 in. by 18 in., and alongside of each side of the main kelson are steel kelson plates 18 in. by 1 in. The *Pretoria* also has six strakes of floor kelsons on each side of her main kelson running the entire length, in size 12 in. by 12 in. All of the frames have an extra floor timber running from bilge to bilge. The frames are moulded out of flitch that is 6 in. thick. On the outside of the frames —at the head of the frames—there runs a steel cord that is 14 in. by 7-8 in. There are also steel arches running along the steel cords amidships to the fore foot forward and under the stern aft. In addition to these the *Pretoria* is diagonally strapped with steel. The diagonals are 5 in. by 1-2 in. These diagonals straps are riveted to the cord, to the arch and at all of the crossings, and go under the turn of the bilge about one-third of the way under the bottom. The cords, arches and diagonal straps are all let into the frames flush, and then the ship is planked so that all of the strapping is concealed.

Upper deck beams of the vessel are 8 in. by 8 in., 8 in. by 9 in., and 8 in. by 10 in. The between deck beams are 11 in. by 11 in., and 11 in. by 12 in. Between each hatch there is an iron rod running from side to side, and this is 1 1-2 in. set up in the center by means of a turn buckle.

The *Pretoria* is supplied with stockless anchors and 1 3-4 in. chain. The windlass is located on the upper deck forward. A submerged tube upright boiler 6 ft. in dia. by 8 ft. high, and allowed 160 lb. steam pressure furnishes steam for the steam deck appliances. A large pony pump is located forward for use in case of fire, for filling the boiler, and also for washing off the decks, etc. A syphon is also located forward. A deck hoist to which bilge pumps are attached is located amidships. The deck hoist is for handling the sails, and also for use in warping the vessels at the wharves. The *Pretoria* is steered by means of a Queen City Hydraulic Steerer.

Crew space is located forward under decks. The cabins are located on the upper deck, and all of the cabins are in the hard wood, cabinet finish. The Master's quarters as well as the officers' are located in the cabin aft. The *Pretoria* is now engaged in the general carrying trade on the Lakes, which consists of coal, ore and grain. While she was built to tow as a consort after large steamships, yet she is equipped with masts, and these masts all have sails, and she has a sail area of 1,800 yards. These sails are utilized when the winds are fair, or in the case of storms, should she break away from the towing steamer, she will be able to take care of herself all right until the weather moderates.



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STATISTICS are usually dry reading, especially when they show conditions unfavorable to the reader's interests. The reverse is the case, however, in the perusal of the complete official returns of the United States Bureau of Navigation for the fiscal year ended June 30, 1900, which show a most pleasing record of progress in construction. The record of the year shows a total of 393,168 gross tons of merchant shipping, a total which has only twice been exceeded since "before the war," that starting point of the decay of the American merchant marine. Not to multiply details, however, we shall here print the document itself:

> Complete official returns for the fiscal year ended June 30, 1900, show that 1,446 vessels of 393,168 gross tons were built and documented in the United States. Since 1856 this record has been exceeded only twice: in 1864, when 415,740 gross tons were built, and in 1874, when 432,725 gross tons were built.
>
> The construction may be classed according to the following types: Schooners, schooner barges, and sloops 499, of 109,605 gross tons; Great Lake steam vessels 25, of 97,847 gross tons; canal boats and barges 523, of 74,860 gross tons; ocean screw steamships 20, of 60,369 gross tons (of which all but one, the *Maracaibo*, 1,771 gross tons, were built wholly or principally for trades reserved by law to American vessels); river steamers 375, of 44,282 gross tons; square-rigged vessels 4, of 6,205 gross tons.
>
> The steam vessels built—420 of 202,498 gross tons—surpass the record, the nearest approach being 1891, when 488 steam vessels of 185,037 gross tons were built.
>
> The steel vessels built—90 of 196,851 gross tons—exceed the previous record year, 1899, when 91 such vessels of 131,379 gross tons were built. Cleveland, Ohio, ranks easily first as builder of steel vessels, with 9 steamships of 42,119 gross tons, followed by Newport News, 7 steamships of 28,202 gross tons; Chicago, 5 vessels, 24,504 tons; Detroit, 4 steamships, of 15,693 tons. During the past decade the steel steam vessels built in the United States aggregate 465 of 742,830 gross tons, of which 198 of 450,089 gross tons were built on the Great Lakes. For comparison it may be noted that the British Board of Trade reports that 727 steel steam vessels of 1,423,344 gross tons were built in the United Kingdom during 1899. During the ten years 69 steel steam vessels, of 194,080 gross tons, were built at Cleveland, and 110 of 138,593 gross tons at Philadelphia.
>
> The total tonnage built and documented on the Great Lakes during the year, 125 vessels of 130,611 gross tons, is the largest in the history of that region. The total for the Middle Atlantic and Gulf coasts, 605 vessels of 135,473 tons, exceeds any record since 1872. The total for the New England coast, 199 vessels, of 72,179 gross tons, has not been equalled since 1891, while the product of the Pacific Coast, 300 vessels, of 40,396 tons, is surpassed only by the returns of 1898 and 1899. Construction on Mississippi River and tributaries, 217 vessels, 14,509 tons, is 9,000 less than 1899. The foregoing figures do not cover yachts or Government vessels.

The last sentence is noteworthy. It recalls the fact that, while the figures given are indicative of the progress of our merchant marine, they do not represent all the activities in marine construction in our yards.

WITH the steady growth in marine construction which the last couple of years has witnessed, there has come an increased demand for skilled workers, especially those trained for usefulness in the drawing room. Workers in the shop can more readily and suc-

cessfully transfer their attentions from one branch of engineering construction to another than can those to whom is intrusted the task of design. In no branch of engineering is there greater need for specialization, or careful training in a particular field, than in marine construction. In fact, the breadth of this field is such that real success is often achieved only by limitation to some particular form of construction. This is not only so with individual designers, but even with yards. The most famous yards in the world have almost without exception built up a great reputation in one particular class of work. This need for scientifically trained men has caused a recent increase in the number of scientific schools which offer special courses in marine construction. Whether this will maintain the equilibrium between supply and demand, or whether supply will at no distant time overbalance demand, is a question that no one can answer now. The survival of the fittest will always operate to bring success to those that deserve it, but this is a slow process of selection. In the meantime the only danger to be feared is the multiplying of facilities for instruction beyond the possibilities of future profitable employment for the graduates. Such conditions tend to cheapen any profession and lead to the deplorable results which are so often observable in the medical, legal and other learned professions. Since our last reference to these increased facilities, the course in Naval Architecture at the University of Michigan has been strengthened by the addition of Professor Herbert C. Sadler, late of the Glasgow University, Scotland, to the faculty at Ann Arbor. Professor Sadler is widely known in the profession on both sides of the Atlantic, and our readers will recall a more extended reference to his capabilities in our description of the course in the Glasgow University, published in the August issue. The course at the University of Michigan, which commenced Sept. 25, is arranged as a graduate course, and commences at the second semester of the senior year, and extends to the end of the fifth year. At the end of the senior year engineering students may receive the degree of Bachelor of Science, and at the end of the fifth year that of Master of Science. For this year only a special course has been arranged which will end in June next. In the future it is proposed to extend the course in naval architecture and marine engineering over one and one-half years. The work will consist of lectures, drafting, and visits to shipyards, and, we are informed, will in general follow the course given at Glasgow University. At the New York University, where a course in marine construction has recently been established under the direction of Professor Carl C. Thomas, arrangements have been completed for the instruction of engineering students in practical shop work. At present the facilities cover machine shop, carpenter shop, pattern shop and forge. Work is also going forward on the equipment for foundry work. In connection with the drawing room for the students of marine construction, floor space has been provided for a mould loft. We understand that it is the intention of the authorities of two other American universities to establish marine courses in the near future.

WE publish on another page in connection with a description of the new German transatlantic liner *Deutschland* a picture of the launching ceremonies, which tells better than a whole volume of words the attitude of Germany toward her merchant marine. Instead of being simply a pleasant incident in the ephemeral history of a private yard, the launching was made a state event of national importance. The Emperor of Germany, accompanied by Count Von Bülow and a brilliant staff, attended the launch, and when the great hull slid into the River Oder, the entire nation watched the event and rejoiced that another agency for the promotion of German interests had come into being. In the complete history of marine construction, the most remarkable chapter would be, without doubt, that devoted to the tremendously rapid rise of the German shipbuilding and shipowning industries. Only a few years ago every ocean liner of importance flying the German flag was foreign built; now ships of the finest construction carry the message of German skill in construction to every port on the seas. More notable still, the supremacy of the seas in the matter of ocean-going vessels rests with the German builders. It matters not that British brains helped to produce these magnificent vessels; the enterprise which made their construction possible, and the skill which put the designs into practical form, are German undiluted. To the fostering care of the government and the wakeful interest of an up-to-date monarch these results are in large measure due. When such results are possible in a country where government by the few obtains, what could not be accomplished in our own country by the united efforts of the governing powers —the people?

BALANCING OF VERTICAL MARINE ENGINES DISCUSSED IN AN ELEMENTARY MANNER.*

BY J. MACFARLANE GRAY.

ELEMENTARY INTRODUCTION.—(SECOND CHAPTER.)

My next auxiliary note is that if in the circle BNE, Fig. 8, any point D be taken and a chord BE drawn through D, then has BD.DE the same value in whatever direction the chord may be drawn through the same point. Bisect BE in C, draw BJ, CK, DL, EM perpendicular to BE, and at the distance BF = DE and the distance BJ = CE draw FH and JM parallel to BE. From inspection of the figure it is then seen that

$$BD.DE = BD.DH + CD^2 = CE^2$$
$$\text{add} \qquad AC^2 = AC^2$$
$$\text{then} \qquad BD.DH + AD^2 = AE^2$$

but AD^2 is constant for the same point D, and AE^2 is also constant, because AE is the radius of the circle; therefore BD.DH must also be a constant product for all lines through the same point D. Therefore if two chords in a circle cut one another, the product of the parts of the one is equal to the product of the parts of

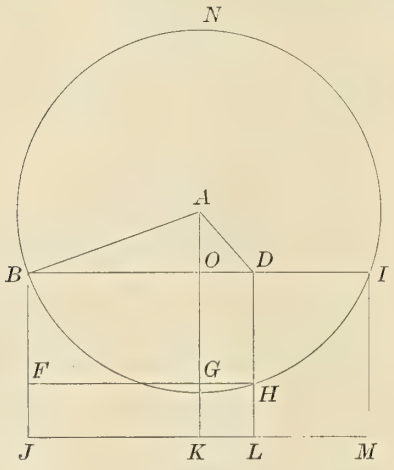


FIG. 8.

the other. This is a property so important to be understood by engineers, I have not hesitated to give you this sufficient demonstration of it, and now I can use this in the reasoning up to balancing.

We want workable expression for the value of x for any position of the crank pin. In Fig. 9, let the two circles be drawn, one with the connecting rod as radius and the other with the length of the crank as radius. Since AD and EF are two chords in a circle cutting one another in the point C, the product EC.CF = AC.CD or $(2nr - x)\,x = (R \sin a)^2$, for CF = x, and AOC = a, and AC = R sin a,

$$\text{therefore } x = \frac{(R \sin a)^2}{2nR - x} \quad \ldots\ldots\ldots\ldots (11)$$

As x is always small in comparison with $2n$R it is customary to neglect it in the division, and to write

$$x = R^2 \sin^2 a \div 2nR \quad \ldots\ldots\ldots\ldots (12)$$

therefore h in Fig. 6, the height of the piston above half stroke position, is

$$h = AB - AC^2 / 2nR \quad \ldots\ldots\ldots\ldots (13)$$

which may be read as

$$h = R \cos a - R^2 \sin^2 a / 2nR \ldots\ldots (14)$$

Here the sloped line stands for "divided by." The rate at which this is changing is the velocity of the piston. We can now write-in these rates of change, for AB it is ω. AC: we have to add to this the rate at

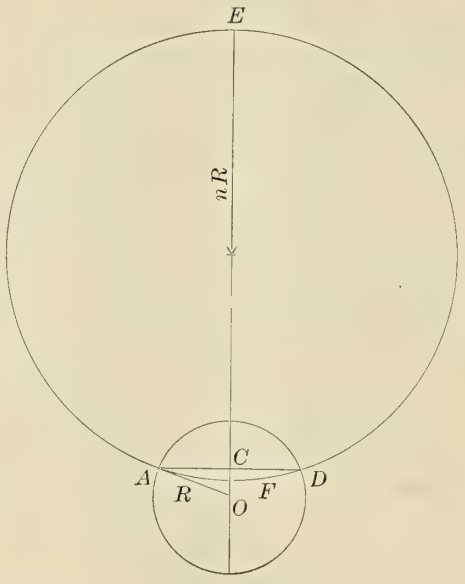


FIG. 9.

which $AC^2/2n$ R is changing. The rate at which the area of a square changes is the product of twice the side of the square by the rate at which the side is changing. In this case, therefore, for AC^2 we have $2AC.\omega.AB$. Therefore the velocity of the piston downwards is

$$\text{velocity} = \omega.AC + 2AC\ \omega.AB / 2nR \ldots (15)$$
$$= \omega.AC + \omega AC.AB nR \ldots\ldots\ldots (16)$$

This is still only velocity, and it is accelerity we want. To get that we have to find out at what rate the last expression is changing. We know how to deal with the first term in it; we had that before, it is $\omega.\omega$ AB. For

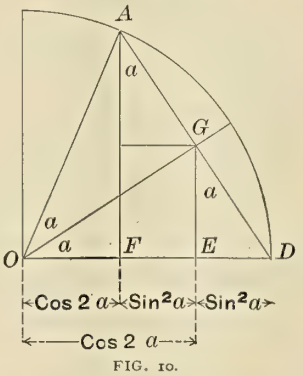


FIG. 10.

the second term, we have to ask ourselves at what rate the area of a rectangle whose sides are AC and AB is changing, knowing the rate at which the lengths of the sides are changing. Evidently this must be the sum of the products of AB by the rate at which AC is changing and of AC by the rate at which AB is changing. As AB is diminishing the latter must be deducted, not add-

*A paper read before the Institute of Marine Engineers, London, England.

ed. Writing these down we have the accelerity of the piston when the pin is in the position A.

$$\text{Accelerity} = \omega\left(\omega AB + \frac{AB.\omega.AB - AC.\omega.AC}{nR}\right) \quad (17)$$

$$\text{or} = \omega^2\left(AB + \frac{AB^2 - AC^2}{nR}\right) \quad (18)$$

$$\text{or} = R\ \omega^2\left(\cos a + \frac{\cos^2 a - \sin^2 a}{n}\right) \quad (19)$$

As some student new to this kind of reasoning may be puzzled over $\cos^2 a$ for $(\cos a)^2$, I explain that the meaning of $\cos^2 a$ is $(\cos a)^2$, and the form $\cos^2 a$ is adopted for convenience, as it cannot lead to any confusion. It is the same with all other trigonometrical quantities.

To simplify (19), observe that in Fig. 10 it is shown that

$$\cos^2 a - \sin^2 a = \cos 2a \quad (20)$$

Making the radius OA = 1 we have OC = cos a,

and OE = cos a. cos a = $\cos^2 a$ (21)

also AC = sin a, and FE = sin a. sin a.

$$\sin a \sin a = \sin^2 a = FE \quad (22)$$

therefore (20), $\cos^2 a - \sin^2 a = \cos 2a$.

We can therefore now write

$$\text{Accelerity} = R\omega^2\left(\cos a + \frac{\cos 2a}{n}\right) \quad (23)$$

This consists of two parts; the first is the primary accelerity as with a slot connecting rod, the other is the

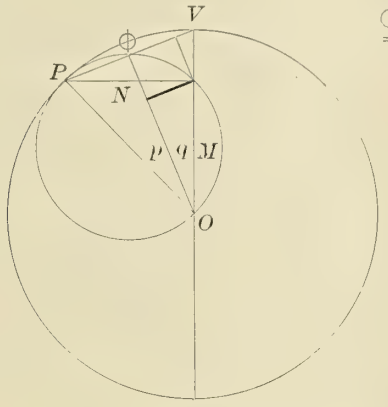


FIG. 11.

secondary accelerity, or what is due to the obliquity of a swinging connecting rod.

What is true for one crank and its weights is also true for any number of cranks on the same shaft. Instead of RW for the product of length of crank by weight for the crank at angle a write the capital letter A, and if there are other cranks with other weights at angles b, c, d, etc., write for these the capital letters B, C, D, etc., and the accelerity force at any instant tending to lift the engines will be equal to the constant $\frac{\omega^2}{g}$ multiplied by ς A cos $a + \frac{1}{n}\varsigma$ A cos 2 a (24)

Here ς stands for the summation of all the quantities similar to that before which it is written, or for A cos a + B cos b + C cos c, etc., and similarly the second term is the sum of $\frac{1}{n}$ (A cos $2a$ + B cos $2b$ + C cos $2b$, etc.). The angles a, b, c, etc., are here the angles of the cranks from the vertical for one position of the shaft; that we elected for the initial position, measured as in Fig. 5.

We have seen that an equivalent crank P at angle p can be found as in Fig. 2 for the effect as with a slot connecting rod, and it is evident that another equivalent crank Q at angle q can be found in the same way for the effect of the swinging connection rod, if we set off the cranks at the angles $2a$, $2b$, $2c$, $2d$, and finally divide by n the ratio of the length of the connecting rod to the length of the crank. These will be the primary equivalent crank and the secondary equivalent crank.

On Fig. 11 let P be the primary equivalent crank in the initial position. Its rectangular components are

$$M = P \cos p = \varsigma A \cos a \quad (25)$$

$$\text{and } N = P \sin p = \varsigma A \sin a \quad (26)$$

when p=POV.

If a circle be imagined as described upon OP and carried round with OP as the shaft revolves to the right, writing p for the varying angle between P and the vertical the vertical line VO, now ΦO will cut this circle and the intercept or chord will always be P cos p, the quantity to be multiplied by $\frac{\omega^2}{g}$ for the primary vertical force.

From the diagram Fig. 11 it is obvious that

$$P \cos p = M \cos \phi + N \sin \phi \quad (27)$$

if ϕ be angle the shaft has rotated from the original position; that is, VOΦ = Φ, and ΦOP = p.

This may be written:

$$P \cos p = \cos \Phi\ \varsigma A \cos a + \sin \Phi\ \varsigma A \sin a \quad (28)$$

It is evident that if we treated the second term of 23 in the same we would get:

$$Q \cos 2q = \cos 2\Phi\ \varsigma A \cos 2a + \sin 2\Phi\ \varsigma A \sin a \quad (29)$$

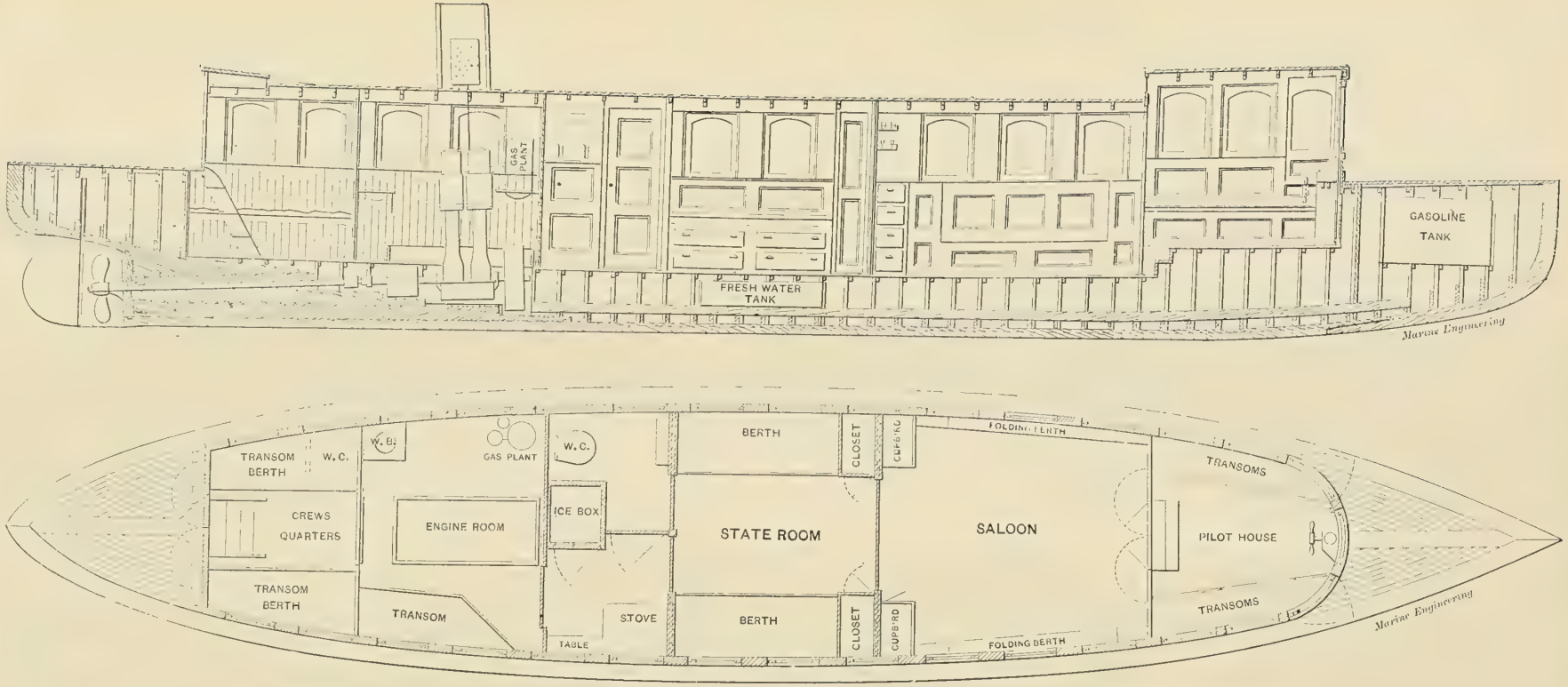
The vertical force lifting the engine is therefore

$$\frac{\omega^2}{g}\left\{\begin{array}{l}\cos \Phi\ \varsigma A \cos a + \sin \Phi\ \varsigma A \sin a + \frac{1}{n} \\ (\cos 2\Phi\ \varsigma A \cos 2a + \sin 2\Phi\ \varsigma A \sin 2a)\end{array}\right\} \quad (30)$$

Gasoline Pleasure Launch Au Revoir

The launch *Au Revoir*, recently constructed by the Greenport Basin & Construction Co. for H. D. Milderberger, forms an interesting example of the application of gasoline motor power to the larger classes of pleasure launch. The chief dimensions of this boat are as follows: Length over all 58 ft., extreme beam 11 ft., draft 3 ft. 1 in. As shown on the accompanying drawing the arrangements provide for a main cabin with saloon and stateroom, while accommodations for the crew are provided forward. The saloon is handsomely paneled in butternut, and is provided with two folding berths so arranged when closed up as to form side panels, while above these a shelf runs the length of the saloon on each side. In order to economize space the doors are fitted to slide on tracks rather than to swing on hinges. The stateroom is finished similarly to the main saloon, and so arranged as to make one large room when both are opened. All mattresses, pillows and cushions are of felt and made by the Ostermoor Co., while pantasote was used in the crew's quarters and engine room.

The motive power is provided by a 16 H.P. Russ motor, which will be found more particularly described on another page of the present issue of MARINE ENGINEERING. As noted on the plans a stack is



PLANS OF THE GASOLINE PLEASURE LAUNCH AU REVOIR, BUILT BY THE GREENPORT BASIN & CONSTRUCTION CO., GREENPORT, L. I.

provided into which the exhaust is led. This also improves the general appearance of the boat. Located just forward of the stack is an air whistle for signaling, etc.

The *Au Revoir* is intended largely for river service, where shoal water prevails, and for this reason it was decided to give the hull proper the full draft, and thus afford better protection to the propeller, rather than use a dropped skag under the wheel with a decreased draft of hull. The lines of the boat have been made as easy and fine as the requirements of the accommodations would permit, and she enters and leaves the water with but little disturbance, even when at full speed. A small boat as a tender is carried on the top of the cabin, the davits for swinging it in and out being fitted on the starboard side.

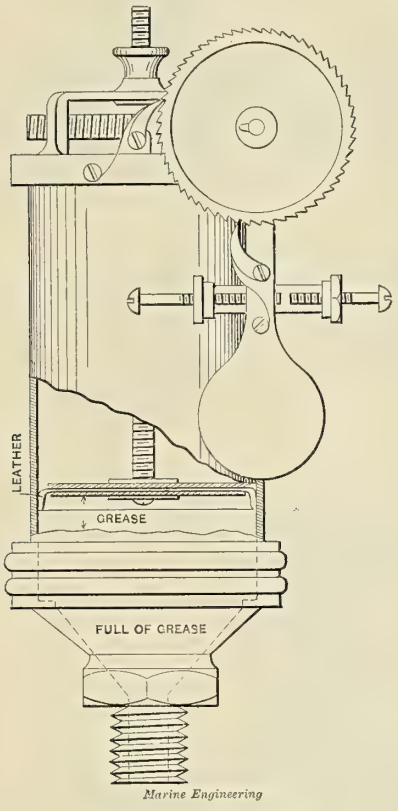
This launch is an example of a class of pleasure boat which is likely to become more common as the practicability of the design and construction become better known—a class of boat large enough to give more accommodation and comfort than can be provided on the usual small size of motor boat, and at the same time having the especial advantages of simplicity of machinery, readiness for instant use, etc., which have made the smaller sizes so popular among the patrons and owners of pleasure craft.

Another interesting feature of this launch is found in the acetylene gas plant for illumination. This provides for the usual interior illumination, and for a searchlight as well. The J. B. Colt Company's apparatus is used, consisting of an improved type of "carbide feed" generator and gas tank with the necessary connections, special burners, etc. The searchlight is 8 1-2 in. dia. and is provided with double reflector and lens, by means of which a brilliant beam of light can be projected upwards of 1,000 feet.

IMPROVED APPARATUS.

Improved Grease Cup.

A novel form of lubricator for use with grease has been brought out by James L. Robertson & Sons, 204 Fulton street, New York, under the name of the Tic-a-toc automatic grease cup. The shank is screwed into the connecting rod end or eccentric strap in the usual way, and the cup is readily detachable for filling

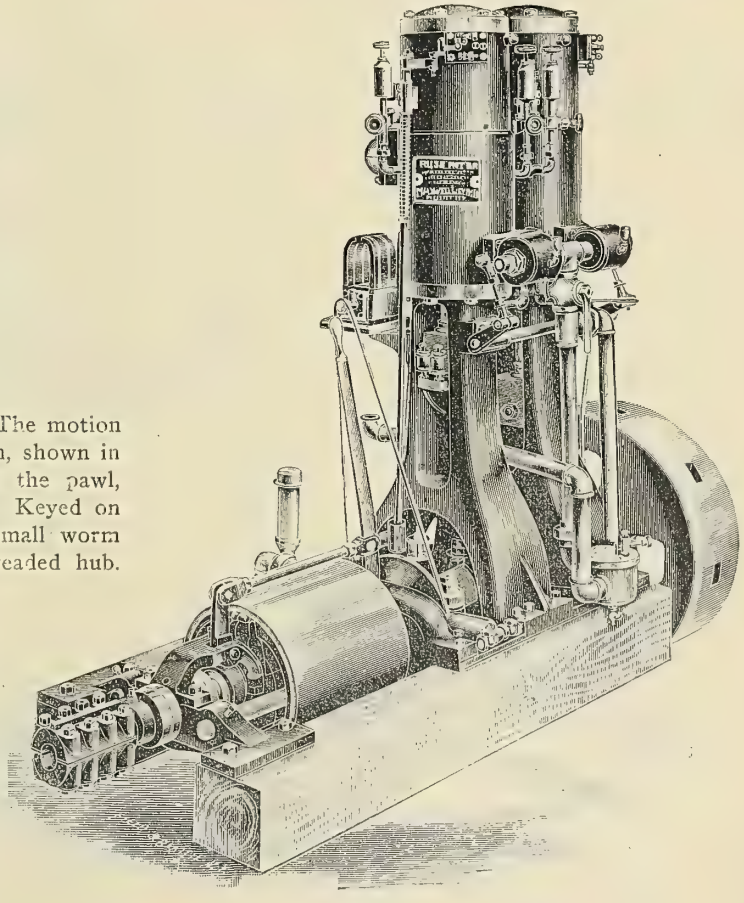


TIC-A-TOC GREASE CUP.

at any time when stopped or under way. The motion of the rod or strap sets the small pendulum, shown in the drawing, swinging, and this operates the pawl, which engages in the ratchet feed wheel. Keyed on to the same spindle as this wheel is a small worm which engages a worm wheel with a threaded hub. Through this hub passes the central screw attached to the plunger inside the cup. To control the swing of the pendulum and the consequent coarseness of feed, two set screws with lock nuts are provided, so that the cup can be adjusted to feed between a wide range of speeds. The feed is positive and automatic, starting immediately as the engine starts, and stopping when the engine has finished turning. The bearings do not have to become warm to start the lubrication. With this form of cup, graphite grease can be used to advantage. It is made in a variety of sizes, containing from 4 oz. to 18 oz. of grease when filled, and is sent on thirty days' trial.

Russ Gasoline Motor.

For marine purposes the Russ motor is intended to use gasoline for the generation of the gas required for its operation. While available for all types of service for which gas engines may be used, special care has been given in the design to the production of a reliable and efficient motor for marine purposes. It is made of the two cycle type, and thus gives a power stroke for each revolution of the engine. It is claimed that in the design of this motor special care has been given to mechanical simplicity and to the reduction of the number of parts, and that all combinations of gears, reducing motion and complicated valves have been avoided. Also in the construction of the motor the arrangements are such that access to any of the important parts can be had without taking the engine apart. The cylinder is carefully water jacketed on all sides, and is thus efficiently cooled no matter what the speed of the engine or the length of the run. In the arrangements for admitting the fresh mixture to the cylinder special care has been taken in the design to insure a uniformity of proportion, no matter what the speed of the revolution, and also to provide for certainty of ignition. The motor is governed through the admission valve wherein it



RUSS GASOLINE MOTOR.

controls directly the amount of fresh charge allowed to enter the cylinder. When running without a load the valve admits only so much of the mixture as may

be needed to keep the engine up to speed, while as the load increases the valve opens under and admits a larger charge until the limit of power is reached. These motors are made in sizes from 6 to 16 H. P. by the Russ Motor Company, of Brooklyn, N. Y., and it is claimed that due to an especial feature of design and construction they will maintain high efficiency for varying power and will operate continually and steadily for long periods of time with minimum wear and tear and expenses for repairs.

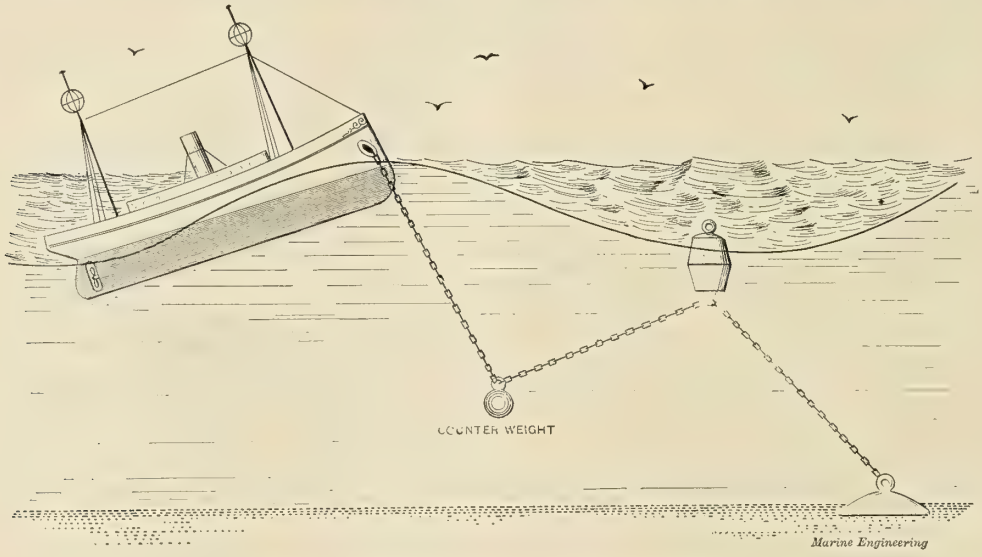


FIG. 1.—SAFETY ANCHORAGE FOR LIGHT VESSELS.

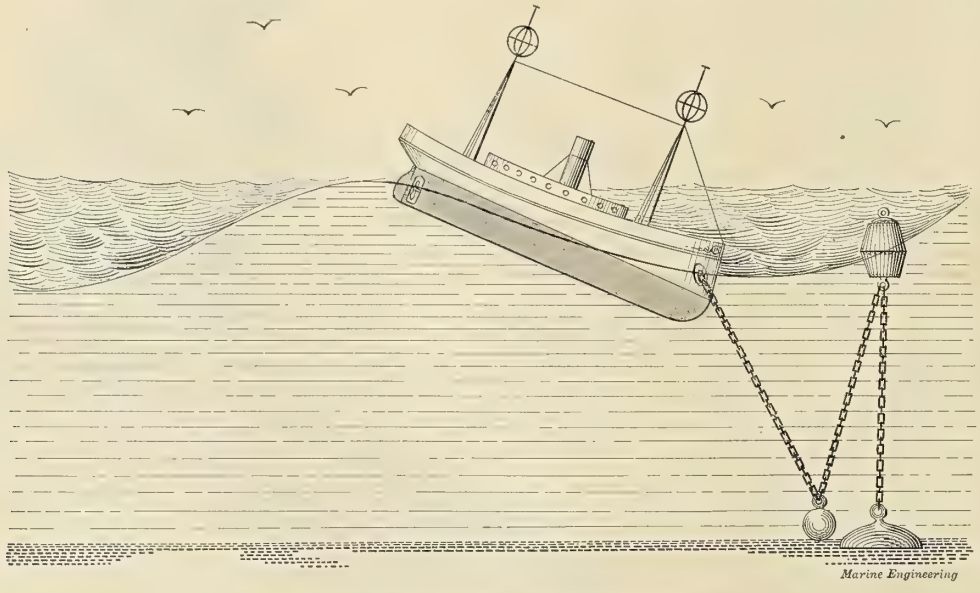
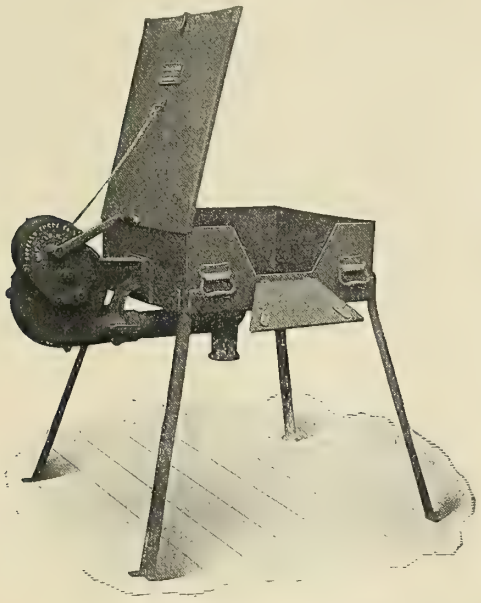


FIG. 2.—SAFETY ANCHORAGE FOR LIGHT VESSELS.

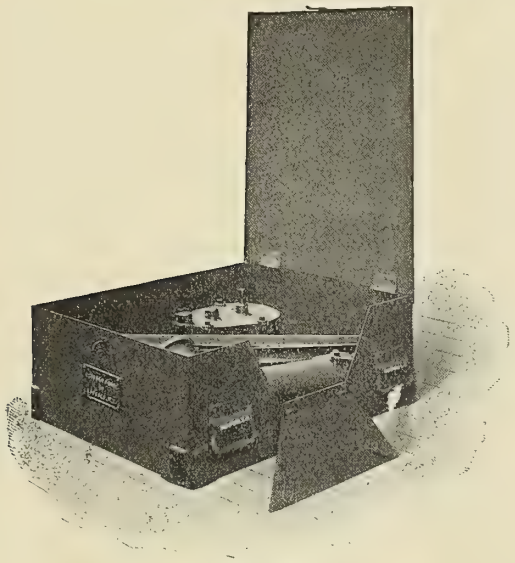
Safety Anchorage for Light Vessels.

The difficulty of keeping a light vessel on her station in every kind of weather, and the danger to navigation when she is shifted by stress of weather is recognized by all men who have to do with the sea. The same applies to buoys, which often drift away from their stations, that usually mark the entrances to channels, dangerous shoals and wrecks, and so deceive the mariner by their false position with which he is not acquainted. A mark which locates a dangerous spot when moved from its proper station can well be compared to a misplaced switch on a railroad. The results are the same—loss of life and valuable property. The strain put upon the cable of a light vessel or buoy in a heavy sea often causes it to part, and the mark is blown from its station. Frequently their anchors are lifted from the bottom as they ride each sea, and little by little the vessel or buoy is moved far from its original location. Thus when it is picked up by the navigator he gets a false bearing, and shipwreck is often the result. To prevent this possibility is the aim of the device represented

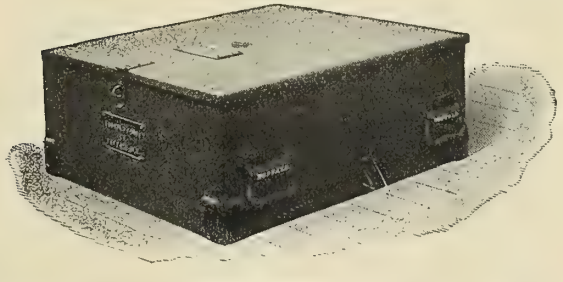
in the accompanying sketches. This device has been worked out by George C. Stanley, of Portsmouth, Va. It consists of a cable counterweight, buoy and anchor. In its operation, as wind or wave move the vessel from the charted position, the cable and counterweight are lifted; the weight of cable and counterweight is then suspended from the vessel to the buoy. As the strain increases the buoy is submerged and forms an elastic loop of the cable with a continuous strain throughout the movement. This allows the vessel to gradually recede with the wave, and as the tension is increased on the cable the vessel comes through the wave in an easy manner and presses forward to buffet the next wave without any sudden stress being placed upon its fastenings. The forces called into play by this anchorage are opposed to one another—the buoyancy of the float and the gravity of cable and counterweight. This method, the inventor believes, makes an elastic and safe anchorage, and allows the vessel to be moored with a short cable in a heavy sea, with the counterweight and buoy almost under the forefoot. The present method of anchorage requires a very heavy cable with many fathoms played out to relieve it from the sudden shock produced by each succeeding wave. Fig. 1 shows the light vessel upon the crest of a wave, with the greatest stress upon its cable and anchor, and the counterweight lifted from the bottom and buoy partly submerged. Fig. 2 shows the return of the vessel from the receding wave and its readiness for the next wave on account of the elastic tension placed on the cable by the float rising on the wave.



FORGE READY FOR USE.



CASE OPENED.



FORGE FOLDED UP.

Buffalo Army and Navy Forge.

In order to supply the rapidly increasing demand for a forge of minimum compass and weight, the Buffalo Forge Company, of Buffalo, N. Y., has recently placed upon the market a portable forge, which embodies many novel features. The forge, here illustrated and described, was designed primarily for use on battleships, cruisers, and merchant vessels. In view of the fact that in such situations space is an item of the utmost importance, the peculiar appropriateness of this forge will be at once recognized. The same features which render it invaluable for use on shipboard must likewise appeal strongly to those who have occasion to transport forges for long or short distances. Although the aim of securing extreme lightness, compactness, and consequent ease of transportation was paramount, those prime requisites of a first-class forge, capacity, durability and efficiency, have by no means been lost sight of. The characteristics thus referred to will be perceived by a glance at the three cuts herewith presented. The first view shows the forge as it appears when set up ready for use. The rigid steel-plate case provides a commodious hearth for the fire, which stands about 30 in. above the ground. To the case are removably attached the various parts, gearing, blower, tuyere and legs. The latter fit into sockets at each corner of the case and at their lower end are flanged horizontally to provide feet for support, as indicated in the first view. An 8 in. crank and handle furnishes the proper speed of rotation to the blast wheel of the blower through a train of four accurately cut gears, enclosed in a dust-proof case. The rotary blower is connected to the orifices in the circular tuyere plate by means of the tuyere pipe, which is formed with a short drop branch for the collection of ash. To facilitate the handling of long bars, a section on each side of the case is hinged so that it may be turned down. As in-

dicated in the second view, the several parts, gearing and blower, tuyere pipe, legs and crank, may be detached and readily packed within the case, leaving in addition sufficient space for blacksmith tools. The third view shows the forge in its most compact form, as it appears when ready for shipping and storage. This also is the form taken on shipboard when not in use. The outside dimensions of the closed case are but 27 1-2 in. by 22 1-2 in. by 10 in., and the weight of the complete outfit, 164 lbs. This is a very small compass in which to pack so bulky a machine as a forge. A hasp provides means for padlocking, and four handles, two on each side, make easy lifting a possibility. In addition the construction is such that the forge may be assembled for use in three minutes. This forge is already in extensive use, though by no means exclusively on shipboard. In addition to the sales in this country, the forge has been introduced abroad and is now in use in the Imperial Japanese Navy. It has likewise been recommended for army use by the quartermaster of the United States Army. It is, in fact, just the thing for transportation on mule back, or for compact storage and shipping.

Fracture of Tail Shaft S. S. Border Knight.

The skill and resourcefulness of marine engineers in making emergency repairs at sea have seldom been better displayed than in the case of the recent breakdown of the British S. S. *Border Knight*, owned by James Little & Co. We are in receipt of a report on this case which deserves a place in the annals of engineering breakdowns at sea. The chief engineer of the vessel, Alexander B. Gerrie, planned the method of repair, and the work was carried out not only under his direction, but with his aid, practically at the risk of his life.

The S. S. *Border Knight* is a steamship of 2,400 tons engaged in direct trade between New York and South African ports. She left the port of Durban, South Africa, June 9 last, and had a splendid run until July 2, when at 2.30 o'clock in the afternoon the tail shaft broke outside the liner and the propeller and taper end went to the bottom. All hands were turned out at once and steam worked back, and to each of the four engineers carried was assigned three helpers to carry out repairs. The Second Engineer started to get the guards off the shaft couplings and the bolts out, and in this work the Third gave assistance. The Fourth went to work to cut and bolt a piece of angle iron across the tunnel underneath the forward end of the intermediate shaft, and to cut up the channel iron which carried the wheel chains and bolt a section of it across the after end of the shaft. The after tanks were then pumped dry and the fore peak filled, but there was so pronounced a swell that it was not considered prudent to draw the tail shaft. To help matters it was decided to flood the forehold to a depth of 6 ft.

A 8 P. M. the engineers knocked off and then worked on watches until 6 o'clock the next morning. An examination of the available tackle showed that it was too light, consisting only of one 2-ton and one 1-ton tackles, while the tail shaft weighed four tons. Next the anchor stock of the kedge anchor was brought down to the tunnel for use as a ram to drive the coupling bolts. At the same time holes were drilled in the tunnel top to hang the tackle, and the gland at the after peak bulkhead was removed.

On the second day after the break the intermediate shaft was lowered, one end resting on the tunnel floor, and the other on the angle iron before mentioned. The tackles were then shifted ready for drawing the tail shaft, and at 9 P.M. every one was then sent to get a good rest until daylight.

On the third day the ship was dipping heavily, her head being kept to the sea by sea anchors. Chief Engineer Gerrie now had a plug made from a wooden fender to fit the stern aperture, and with this he was lowered over the side. Meanwhile the Second made preparations inside for withdrawing the tail shaft, and as he drew it inboard the Chief inserted the plug and made it tight, thus preventing any flooding or leaks. The tail shaft was drawn in past the channel iron, before referred to, and the channel was put up again and the weight of the shaft taken on it. One end was then lowered to the tunnel floor, and the other end having been heaved up by the tackle, the channel iron was taken down and the shaft lowered to the floor. The spare tail shaft was then gotten in place in the reverse manner and run out until it met the plug. The engineers worked all night getting the coupling bolts and everything in readiness for the final adjustment.

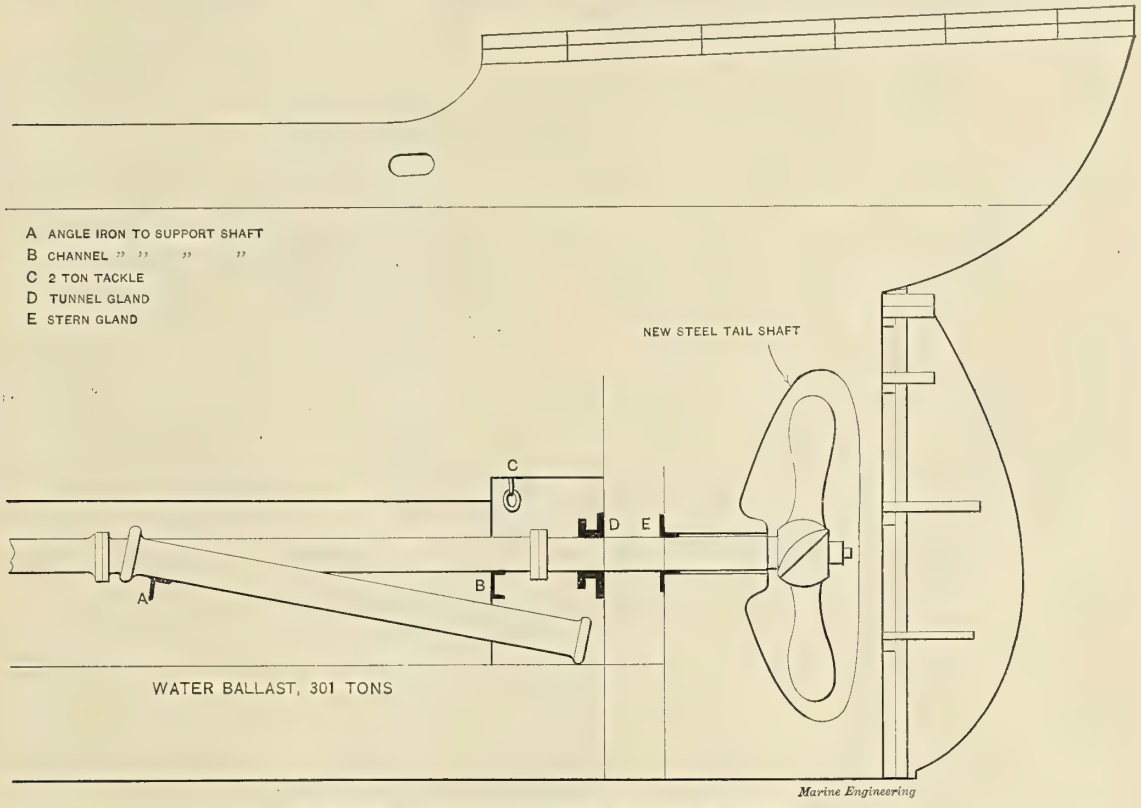
On the fourth day the tail shaft, having been protected at the outboard screwed end by wrappings of spun yarn, was pushed out flush with the boss and was ready for fitting on the propeller at 9 A. M. The propeller was now hoisted over the port side and lowered into the aperture in a very skillful and seamanlike manner by the deck department. As there was a nasty swell on, progress was slow and the work difficult and dangerous. Finally the propeller was centered in the aperture and the tail shaft pushed out, and after a good deal of effort the key was entered and the outside nut screwed on for two threads distance by about 6 P. M. All that night the engineers worked in the tunnel, coupling up the shafting and drilling the propeller spanner for a shackle.

At daylight on the fifth day the Chief Engineer was lowered down on the propeller with the propeller spanner, and with the aid of a wire purchase on the after winch tightened up the nut and got the pin in place ready for steaming. At 11 A. M. the sea anchor was taken in and the *Border Knight* proceeded under her own steam to St. Lucia, having been stopped only 4 days 3 1-2 hours.

The skill with which the repairs were effected is shown in the fact that no mishap occurred to the personnel—not even a crushed finger. While working outboard Chief Engineer Gerrie was frequently submerged, and so jarred that he bled freely from his ears and nostrils. There were sharks all about, too, and it was found necessary to catch four of them and chop them up to feed the others before work at the water line could be safely carried out. During the operations the Chief Officer of the ship was washed overboard and was rescued with difficulty—but on his return to the ship remained actively on duty.

As a result of his experience, Chief Engineer A. B. Gerrie is of the opinion that in such an emergency after the propeller is over the side and in the screw aperture, it would be better to take in the sea anchor and let the vessel roll so as to minimize the pitching, which naturally greatly delays the work.

At St. Lucia the vessel was viewed by Lloyd's Inspectors, who found everything in a tight and satisfactory condition, and upon their report the Lloyd's headquarters at London subsequently voted a special medal in recognition of his work in saving the vessel and crew. To Captain W. F. Splatt and Chief Officer Mathie special credit is given by Chief Engineer Gerrie for valuable services rendered during the work of repair.



ROUGH SKETCH SHOWING METHOD OF REPAIRS S.S. BORDER KNIGHT.

U. S. S. WYOMING.—The U. S. Monitor *Wyoming* was launched at the Union Iron Works, San Francisco, September 8. Miss Hattie Warren, daughter of United States Senator Warren, of Wyoming, performed the ceremony of christening. This vessel is one of the four single-turret, harbor-defense monitors, authorized by Act of Congress, May 4, 1898. She is of these dimensions: Length, l. w. l., 252 ft.; extreme beam, 50 ft.; mean draft, 12 ft. 6 in.; displacement, about 3,200 tons. She will be fitted with twin screw, triple-expansion engines, and Babcock & Wilcox water tube boilers. The estimated speed is 11 1-2 knots. The main battery will include two 12 in. breech-loaders, and four 4 in. rapid fire rifles. The armor varies in thickness from 11 in. on the side to 1 1-2 in. on the protective deck. The contract date of completion is March 5, 1901.

ACTION OF BILGE KEELS FROM A HYDRODYNAMICAL POINT OF VIEW.—I.*

BY G. H. BRYAN, F.R.S.

I.—INTRODUCTION.

(1) The means adopted for moderating the rolling of ships have been recently brought before my notice in a paper by W. J. Luke, and the discussions accompanying it in the Transactions of the Institution of Engineers and Shipbuilders in Scotland (XLIII. 2, 3) for December, 1899, and January, 1900. On reading this paper, I was much impressed with the efficacy of bilge keels in extinguishing rolling, as these appeared to furnish a beautiful practical illustration of the properties of discontinuous motion which have for many years been a favorite subject of study among applied mathematicians. I at once wrote to Dr. Elgar, inquiring how far the theory of the bilge keel had been treated from a hydrodynamical point of view, and, at his suggestion, the following paper has been prepared, in the hopes that a theoretical discussion of the principles underlying the use of the bilge keel may prove of use in any further experiments that may be undertaken. In Sir William White's paper of 1895 allusion was made to the investigations then about to be undertaken by R. E. Froude, but from Mr. Luke's paper (page 23) it appears that an account of these had not yet been published.

(2) The primary object to be kept in view in every device for extinguishing the oscillations of a ship is

*Read before the Institution of Naval Architects, London.

the absorption or dissipation of the energy of the oscillatory motion. The use of internal water-chambers communicating with one another by a large number of small holes as described by Mr. Watts in 1883 and 1885 affords an excellent illustration of this property. In consequence of the resistance offered to the flow of water from one chamber to the other and back, energy is absorbed from the water and is ultimately converted into heat in much the same way as in Joule's classical experiment of determining the so-called mechanical equivalent of heat.

With the use of bilge keels, the energy of oscillation has to be absorbed by the water surrounding the ship; and there are three ways in which a fluid can absorb energy:—(1) By viscosity; (2) by the production of discontinuous motions; (3) by the generation of waves. Now, the effects of viscosity may naturally be expected to manifest themselves more in retarding the motion of the ship than in extinguishing oscillation, and the fact that bilge keels do not increase the resistance on the ship to an appreciable extent shows that their action cannot primarily be due to viscosity. As to the effects of viscosity in determining the ultimate form of the dissipated energy, these are of no great importance to the naval architect.

We are thus left to deal with discontinuous motion and wave motion. The question as to the relative extent to which the action of bilge keels depends on these two causes may not be devoid of practical interest. It is clear that a ship which readily expends its oscillatory energy in forming waves may, under other conditions, all the more readily absorb energy from certain types of waves, on somewhat the same lines as, in the radiation of heat, good radiators are good absorbers; in other words, a ship which generates the most waves when it rocks is the most easily set in motion when waves of the proper period strike it.

(3) The object of this paper is to show that the efficacy of bilge keels in extinguishing rolling motion, in virtue of the discontinuous motions they produce, is materially greater than would be directly inferred from experiments on the co-efficient of resistance of a lamina moving in water. It must be clearly borne in mind throughout what follows that we are not considering the total extinctive effects, but merely the amounts by which these are increased by the addition of bilge keels to a ship which previously did not possess them. In a ship unprovided with bilge keels and possessing no sharp edges projecting into the water, discontinuous motions cannot exist at the velocities due to ordinary moderate rolling motions. In such cases the extinction of oscillation is doubtless due to wave formation, aided to some extent by viscosity. But when a bilge keel is added with a sharp edge, discontinuous motion is at once set up, the fluid motions being divided into two parts by a surface of discontinuity thrown off from the sharp edge, and it is my purpose to prove that the advantage of the ship with bilge keels over the same ship without them can be accounted for by discontinuous motions to a greater extent than would appear at first sight probable. It is not contended that the effects of wave motion are not also of importance in this connection, but they probably are secondary in character, their action being due to the influence of the waves in modifying the discontinuous motions, as well as to the presence of the bilge keels causing a modification in the waves by which their absorption of energy may be materially increased.

For this reason wave motion has been entirely left out of account in the calculations which I have made, a simplification which is, moreover, necessary in order to bring the problem within the range of existing methods of mathematical analysis. At the conclusion of the paper I propose to indicate lines on which experiments might be conducted with a view of putting the matter to a practical test.

(4) Sir William White tells us that the late Mr. Froude's experiments made with a paddle oscillating in water gave a co-efficient resistance of 1.6 lb. per square foot, with a mean velocity of 1 ft. per second, and that the use of this co-efficient does not fully account for the experimental facts. "On the other hand," Sir William White goes on to say, "in the case of the *Sultan*, the agreement between Mr. Froude's estimate, based on the use of this co-efficient and the experimental facts, was very close indeed."

Now the diagram shows that the midship section of the *Sultan* is *rounder* than that of the *Revenge;* and, moreover, the bilge keels were placed one near the bottom, and the other rather below the point where the contour is most curved. The section given of the *Revenge* shows that the submerged portion is more nearly of the form of a *rectangle* with rounded corners; and, moreover, the bilge keel is placed at the most protuberant part of the contour. In Mr. Luke's diagrams the angular forms of the midship sections of most ships and the far more nearly circular section of the *Sultan* are noticeable, while in diagrams of the *Campania* and *Omrah,* kindly sent me by Dr. Elgar, the section is approximately a rectangle with the corners rounded off. A glance at the diagrams suggests that the differences in the behavior of the bilge keels largely depend on the forms of the midship sections, and we are thus led to the following proposition:

The resistance to discontinuous motion due to bilge keels is greater in a ship of somewhat angular section than in a ship of circular section, provided that the keels are attached at the protruding corners of the section.

(5) The angular contour of the midship section increases the efficacy of the bilge keel in two distinct ways:

(*a*) The motion of the ship produces currents in the water which flow past the bends in the opposite direction to that in which the ship is turning, thereby producing an increase of pressure on the bilge keels.

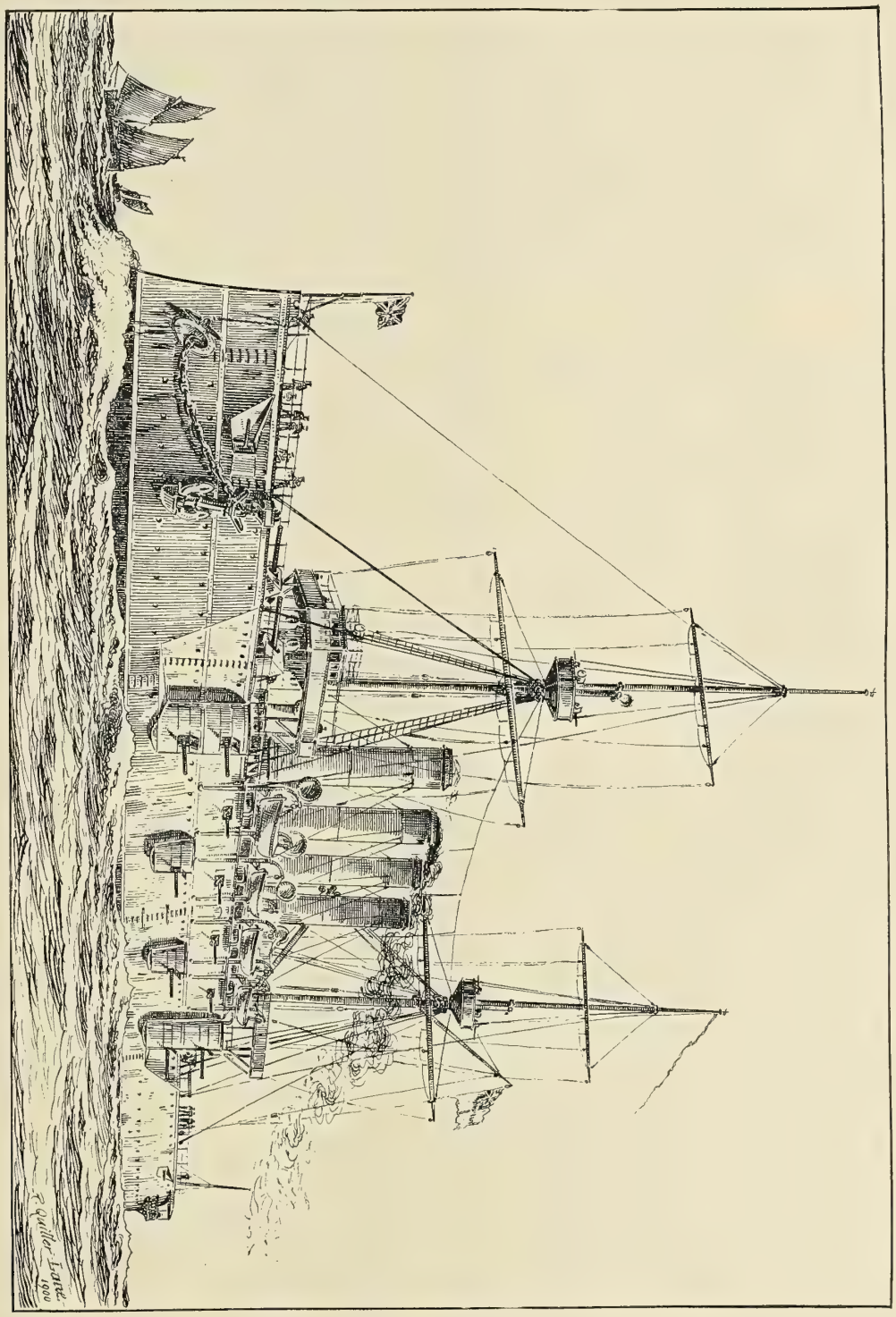
(*b*) The discontinuous motion past the bilge keels alters the distribution of pressure on the sides of the ship, and for a rectangular section the differences of pressure thus produced have a moment always tending to retard the rolling motion.

Sir William White was evidently alluding to some such consideration as these in his remark:—"But, as

the matter at present stands, it would appear that the *Revenge* experiments point to a possibility which is also indicated by the results given by Mr. Froude in 1874. It appears that when bilge keels are added to a ship they must become effective, not merely as flat surfaces oscillating with the ship, and experiencing direct resistance, but by indirectly influencing the stream-line motions which would exist about the oscillating ship if there were no bilge keels."

British Armored Cruiser Aboukir.

A fine example of an armored cruiser of a type now building for the British Navy is shown in the accompanying sketch of H. M. S. *Aboukir,* recently launched from the Fairfield yard at Govan on the Clyde. This vessel is a first-class steel, sheathed, armored cruiser of these dimensions: Length, 445 ft.; beam, 69 ft. 6 in.; mean draft, 26 ft. 3 in.; displacement, about 12,000 tons. The *Aboukir* will be fitted with twin screws driven by



FIRST-CLASS SHEATHED ARMORED CRUISER ABOUKIR, 12,000 TONS DISPLACEMENT, FOR BRITISH NAVY.

triple expansion engines, with cylinders 36 in., 59 in., and (two) 68 in. dia., and 4 ft. stroke, of 21,000 collective horse-power. Steam will be furnished by thirty Belleville water tube boilers fitted with economizers arranged in four groups, each group fitted in a separate water-tight compartment. The boiler pressure will be 300 lb., reduced at the engines to 250 lb. The estimated speed is 21 knots. For protection the *Aboukir* will have an armor belt of 6 in. nickel steel for 230 ft. of her length and 11 ft. 6 in. deep. Harveyized steel 12 in. thick will be used for the conning tower, and the barbettes will be protected with 6 in. armor. Bulkheads will be of 5 in. nickel steel, and the protective deck will have a maximum thickness of 3 in. The armament will include two 9.2 in. and twelve 6 in. guns, also fourteen 12-pounders, besides several boat, field, machine, and automatic guns. There will be two 18 in. submerged torpedo tubes, fitted broadside. The complement is 750 officers and men.

San Francisco Dry Dock.—The proposed new graving dock to be built at Hunter's Point, in San Francisco harbor, will be operated by the San Francisco Dry Dock Co., which has taken over all the dock interests of the old California Dry Dock Co. These include an existing graving dock, in dimensions: Length, 490 ft.; beam, 125 ft.; depth, 24 ft.: also two floating docks of 3,000 tons and 1,200 tons capacity, respectively, and a marine railway capable of handling any vessel up to 800 tons. The new dock will be excavated in the solid rock, which at the Point is green serpentine. The plans call for a dock 750 ft. long, 122 ft. wide at the coping, 74 ft. wide at bottom, 32 1-2 ft. deep over sill below coping, and with 28 ft. of water at high tide. In dimensions, therefore, the dock will be one of the largest in existence. Concrete will be used for the interior facing of the dock, and granite for the approach and seat for the caisson. The keelson and working floor will be of Douglas fir well anchored and embedded in a sub-floor of concrete. The entrance to the dock will be closed by a steel floating caisson, which measures, length, 104 ft.; beam, 28 ft.; depth, from bottom of keel to underside of upper deck, 33 ft. 9 in. Wharf approaches on either side of the entrance to the dock will be constructed by piling, and will be about 200 ft. long and 60 ft. wide. The pumping plant will consist of three centrifugal pumps, each having a 38 in. discharge. The combined capacity of these pumps is 110,000 gal. per minute. They will be arranged with double suctions, so that they can empty both or either of the dry docks. Two hours is the estimated time for emptying the new dock, and forty-five minutes the old one. Three Corliss engines, 24 in. by 48 in., and each of 345 H. P., will operate the pumps by the rope drive, the engines being located on the surface and the pumps in a pit on a level with the bottom of the dock. Steam will be supplied by six water tube boilers, and there will also be a 75 H. P. donkey boiler for furnishing steam to the drainage pumps and power capstans. A brick stack 110 ft. high and 7 ft. inside dia. will be put up on the boiler house. The officers of the dock company are: President, William Babcock; Vice-president, J. H. Meyer; Secretary, W. F. Russell. Howard C. Holmes is the engineer in charge of the work.

LAUNCHES—HOME AND FOREIGN.

S. Y. Lysistrata.—The large full-powered, sea-going steam yacht *Lysistrata*, for James Gordon Bennett, owner of the *New York Herald*, was launched from the Denny yard, at Dumbarton, on August 28. This vessel is of the following dimensions: Length on waterline, 285 ft.; length over all, 314.5 ft.; breadth, extreme, 39.9 ft.; Thames tonnage, 2,082. She has a straight stem and long stern, and there is a full poop aft, a long shade deck amidships, and a short turtle-back forward. Unlike other large yachts, she has only one mast, which is placed aft of the funnel, and has a short yard for signaling purposes only. On the shade deck there are two deckhouses. The after one contains a large smoking-room with a vestibule, from which a stair leads to the main deck. The forward one contains a private business-room and state-room for the owner, and a chart-room. Above this deckhouse is the navigating bridge. Under the shade deck there is a long range of deckhouses. At the forward end of this is the dining-room, a state-room with dressing-room, bath-room, and a Turkish bath-room. From here also a fine stairway leads to the private staterooms below. Between the engine and boiler casings the galley and pantry are situated, and at the after end of this deckhouse there are six comfortable state-rooms with bath-rooms attached. Under the poop deck are crew's galley, cow-house, officers' and crew's lavatories and w.c.'s. On the lower or cabin deck forward are five large state-rooms (one of them 20 ft. sq.), with dressing-rooms and bath-rooms adjoining. Forward of these there are a number of rooms for private servants. The officers and crew have fine accommodation on the cabin deck aft. Ample store-rooms and refrigerating-rooms are provided for the owner in the forward hold, and similar rooms for the officers and crew aft. The machinery of the yacht consists of two sets of four-crank triple-expansion engines, and four single-ended boilers of the cylindrical multi-tubular type, with a donkey boiler of the same type. She has ample coal bunkers, and it is intended she should attain a high speed. She will be lit throughout with electric light.

S. S. City of Rockland.—The cargo and passenger steamer *City of Rockland*, for the Boston & Bangor Steamship Co., was launched at the McKie shipyard, in East Boston, September 11. The new vessel is a side-wheel steamer of these dimensions: Length, 300 ft.; beam, 30 ft. over hull, and 62 ft. over guards; depth of hold, 14 1-2 ft. She will be fitted with a beam engine, constructed by the W. & A. Fletcher Co., of Hoboken, N. J. This engine will have a cylinder 63 in. dia. and 122 in. stroke, of about 1,700 horse-power. The side-wheels will be of the feathering type, 25 ft. in dia., and 10 ft. face. There will be accommodations for a large number of passengers in 200 state-rooms and parlors. The vessel is built of oak. It is expected she will be on her station next May.

Sch. Thomas S. Dennison.—The wooden four-masted schooner *Thomas S. Dennison* was launched from the Dunn & Elliott yard, at Thomaston, Me., on August 25. The vessel is of these dimensions: Length, 218 ft. 2 in.; beam, 43 ft. 7 in.; depth, 19 ft. 7 in. The vessel has a capacity of about 2,000 tons.

I. R. C. Nowik.—At the Schichau yard in Dangzig, on August 15, the Russian Cruiser *Nowik* was launched. This cruiser has a length of 347 ft. 8 in., a beam of 40 ft., and on a draft of 16 ft. 5 in. will have a displacement of about 3,000 tons. The bunker capacity is 500 tons, and will insure a radius of action of about 6,000 miles. This vessel has triple screws, and three engines of 18,000 collective I.H.P. This is expected to give a speed of not less than 25 knots. On account of her high speed the *Nowik* will be chiefly used as a scout and dispatch vessel. She will have three funnels and a signal mast, with fighting-top and signal yard, as well as three large electric searchlight projectors. The vessel is fitted with a heavy protective deck, and will have the following armament: Six 12 cm. and six 4.7 in. quick-fire guns, one Baranowsky gun, and six torpedo tubes, with three 8 mm. machine guns in the fighting-top.

Sch. Geneva.—The four-masted schooner *Geneva* was launched at the yard of Cobb, Butler & Co., of Rockland, Me., on September 20. She is of these dimensions: Length, 190 ft. 6 in.; beam, 37 ft. 2 in.; depth, 17 ft. 5 in.; net tonnage, 776 tons, carrying capacity, 1,300 tons. The vessel has two full decks and poop deck extending forward to the mainmast. Her masts are of Oregon pine and are 92 ft. in length She is owned by John S. Emery & Co., of Rockland, Me., and has been chartered to load a cargo of coal at Baltimore, for Pernambuco, Brazil.

Sch. J. Edward Drake.—The four-masted wooden schooner *J. Edward Drake* was launched at the yard of the New England Co., Bath, Me., on September 11. The vessel measures: Length of keel, 190 ft.; beam, 37 ft.; depth, 17 ft.; gross tonnage, 910 tons. The keel is of oak, the frames of hackmatack and other hardwoods, the ceilings of pine, and the planking of yellow pine. The vessel is fitted with two discharging hatches 11 ft. sq. She is also fitted with a Hyde windlass outfit. She is owned by James B. Drake, of Bath, Me.

S. S. Canadian.—The S. S. *Canadian* of the Leyland Line, was launched on the Tyne, England, August 11. This vessel is of the following dimensions: Length, 550 ft.; beam, 59.6 ft.; depth of hold, 47 ft. She is fitted for general cargo and cattle carrying trade, having accommodations for 820 live stock. She will also have passenger accommodations for about 100 cabin passengers. The vessel will be put in service on either the New York or Boston route of the company. Her speed will be about 15 knots.

Sch. Thallium.—The schooner *Thallium* was launched from the yard of McKay & Dix, Bucksport, Me., on August 23. She is of the following dimensions: Length, 164.3 ft.; beam, 36.6 ft.; depth, 16.7 ft.; gross tonnage, 729.28. She was built expressly for the cryolite carrying trade between the Greenland mines and Philadelphia. The vessel is owned by Capt. C. B. Dix, of New York.

Tow Barge.—One of the four lime barges for the Rockland, Rockport, Lime and Cement Co., ordered from the Harlan & Hollingsworth Co., of Wilmington, Del., was launched from their yard, August 23.

T. S. S. Justo Chermont.—This steel twin-screw vessel for the Amazon Navigation Co., was launched from the yard of Laird Brothers, Birkenhead, August 25. The vessel is of these dimensions: Length, 230 ft.; beam, 35 ft. 6 in.; depth, 11 ft. 9 in.; cargo capacity, 300 tons on 7 ft. 6 in. draft; speed, 13 knots. She is to have two sets of triple-expansion engines, and two steel double-ended return tube boilers, built for 175 lb. working pressure. A sister vessel, the *Campos Salles* was recently completed by the same builders for the same service.

Tug Oscar G. Murray.—The steel tug *Oscar G. Murray*, for the Baltimore & Ohio Railroad, was launched at the yard of the Spedden Shipbuilding Co., of Baltimore, September 15. The tug is of these dimensions: Length, 105 ft.; beam, 22 ft.; depth, 12 ft. 6 in. She will be fitted with a fore and aft compound engine, with cylinders 20 in. and 40 in. by 28 in. The vessel is named after the first vice-president of the Baltimore & Ohio Railroad Co.

Dredge.—The vessel, said to be the largest dipper dredge in America, was recently launched at the St. Lawrence Marine Railway Co., Ogdensburg, N. Y. She is of the following dimensions: Length, 115 ft.; beam, 40 ft.; drawing 12.2 ft. at working end and 10 1-2 ft. at stern. She is to be taken to Massena to cut a channel in the proposed canal through from the St. Lawrence to the Grasse River.

Sch. John W. Dana.—The three-masted wooden schooner *John W. Dana* was launched from the yard of F. S. Bowker, Phippsburg, Me., August 25. The vessel was built for the West Indian trade, and is of these dimensions: Length of keel, 153 ft.; beam, 34 ft.; draft, 13 ft.; carrying capacity, about 1,000 tons. She is owned by John W. Dana, of Portland, Me.

Sch. Medford.—The four-masted schooner *Medford* was launched from the yard of Kelly, Spear & Co., of Bath, Me., on August 29. She is of the following dimensions: Keel, 190 ft.; beam, 40 ft.; depth, 23 ft.

Freight Lighter.—A large freight lighter, the last of an order for five for the Baltimore & Ohio Railroad, was launched September 11, at the yard of William N. Skinner & Sons, of Baltimore.

Barge Theodora Palmer.—The wooden barge *Theodora Palmer*, of 3,000 tons capacity, for the Thames Towboat Co., was launched from the Noank shipyard, Noank, Ct., August 25.

S. S. St. Paul.—On a recent west bound trip, the American liner *St. Paul* made the passage from Cherbourg to New York in 6 days, 7 hours and 6 minutes, beating her own record and that of all other liners on the route, with the exception of the two new German fliers. On the way across, the *St. Paul* passed the Cunarder *Campania*, and docked in New York considerably ahead of that vessel.

A preliminary trial in the Kennebec River, the U. S. torpedo boat *Barney*, 167 tons displacement, built by the Bath Iron Works, is reported to have shown a capacity for high speed. The contract speed is 28 knots.

On a recent trial the Parsons turbine driven destroyer *Cobra* is reported to have attained a speed of 37.7 knots.

Obituary.

Arthur Sewall, shipbuilder and shipowner, of Bath, Me., died at his summer residence at Small Point, near that city, September 5. He was a native of Maine, having been born in Bath, in 1835. In that city he received his education, and when he left school he entered his father's shipyard, then one of the largest on the coast. In 1854 Mr. Sewall associated himself with his brother Edward, in shipbuilding and shipowning enterprises, under the firm name of Arthur Sewall & Co. To the efforts of this firm are in large measure due the existence of the American flag in the foreign freight trade. In 1894, the firm built the first steel sailing ship constructed in this country, the material being specially imported for the purpose. Later, other and larger vessels were built from domestic materials. Deceased was honored by the nomination for Vice-President of the United States on the Democratic ticket in 1896, a place which he had not sought. His death removes one of the strongest supporters of the American foreign shipping interests A widow and two sons, Harold M. and William D. Sewall, survive.

Robert W. Linn, one of the pioneer builders of wooden vessels on the Great Lakes, died in Detroit last month, aged 70 years. He came to this country originally from Scotland, and first engaged in the shipbuilding business at Gibraltar, Mich. At one time deceased had as a partner Mr. Craig, now of Toledo, Ohio. No vessels have been built at the Gibraltar yard for several years.

Turbine Driven Vessels.—It is not improbable that the turbine motor may be applied to passenger service in the near future. In the Channel service, between England and Ireland and England and the Continent, high speed seagoing vessels abound. The London, Brighton and South Coast Railway has under construction plans for a Parson's turbine driven vessel for the Newhaven-Dieppe route. Another large corporation, the London & North Western Railway Co. is understood to be contemplating the use of the turbine motor in the projected steamer *Scotia* for express service between Holyhead and Dublin. In both of these cases it is more than likely that the hulls would be built at the Denny yard at Dumbarton, on the Clyde. The success which has attended the trials of the destroyers *Viper* and *Cobra* has done much toward making the turbine driven vessel a possibility. The last named vessel built by Armstrong, Whitworth & Co. on the Tyne, on speculation, has recently been purchased by the British Admiralty.

Water Tube Boilers.—A strong committee has been appointed for the purpose of investigating the boiler question in the British Navy under the presidency of Vice Admiral Sir Captain Domville, R. N. The membership includes superintending engineers of large lines of merchant vessels, a scientist and a member of the engineer corps of the Royal Navy. The committee will carry out a very exhaustive inquiry into the merits and demerits of the Belleville water tube boiler for naval purposes as compared with the cylindrical tank boiler. Other forms of boiler will be considered and also the important question of auxiliaries. Practical and experimental trials will be conducted.

QUERIES AND ANSWERS.

(Communications intended for this department will not receive attention unless accompanied by the full name and address of the sender, which will be considered confidential.)

Q.—(1) As I understand it, the resistance makes the field coil get hot, and in order to avoid the heating more wire is added to the field; now, if resistance is what heats the coils, how do you account for coolness of the field after adding more wire, consequently more resistance?

(2) What is the cause of the humming in the fields and pole pieces of an induction motor, when the armature is not revolving, but the current is passing through the fields?

(3) What changes are necessary to reverse the running of an induction motor? Crossing the positive and negative wires at binding-post will not do it.

L. C. S.

A.—(1) The resistance is not what makes the field coil get hot. What heats it is the energy required to force the current through the wire against the resistance, and this energy is equal to the resistance multiplied by the square of the current, the resistance being measured in ohms and the current in amperes. If the resistance is increased the current is reduced, and as the square of the latter enters into the multiplication the product is reduced To illustrate, suppose the resistance is 100 ohms and the current is 2 amperes, then the energy expended in heating the field coil will be $2 \times 2 \times 100 = 400$ watts. Now, if the field resistance is increased to 200 ohms, the current will be reduced to 1 ampere, and the energy expended in the field in developing heat will be $1 \times 1 \times 200 = 200$ watts

(2) The cause of the humming, when the armature is not revolving, is that under such conditions the iron is subjected to two strong magnetizing forces which act in opposite directions, or pull against each other, so to speak, and this action produces a very rapid vibration of the metal, which results in developing a humming noise.

(3) To reverse a two-phase induction motor, reverse the two wires of one circuit, leaving the wires of the other circuit unchanged. To reverse a three-phase induction motor, reverse any two wires.

Q.—Will you please answer the following question: If 80 gallons of feed water per minute at 180° pass through a coil heater of 3,050 sq. in. heating surface, heated to 370°, at what temperature will it enter the boiler? A Subscriber.

A —No exact answer can be given to this question by any process of mere computation. The result will depend on many other conditions which are not stated, and which cannot be definitely known. The chief of these are: (1) The character and condition of the surfaces in the heater, whether clean or coated with scale or grease (2) The arrangement of the coils in the heater with reference to the velocity of circulation, recent experiments showing that the efficiency of a feed heater is to a considerable extent dependent on this feature. Making the best estimate possible regarding these various points, however, it is not likely, under the conditions stated, that 1 square foot of the surface will transfer more than about 600 heat units per minute. The heater as a whole has about 21 sq. ft of surface, and this would give $21 \times 600 = 12,600$ heat units transmitted through to the water. Taking 8 lb. to the gallon, we have this amount of heat absorbed by 640 lb. of water. This gives a rise of temperature of $12,600 \div 640$, or about 20 degrees. This estimate might, however, widely vary under different conditions.

It will be noted that the heater mentioned is entirely too small for this quantity of water, which amounts to about 38,400 lb. per hour. This is enough for a modern 2,500 I.H.P. triple-expansion engine, while 21 sq. ft. of heater surface would mean only a little vest-pocket heater, say about 12 in. dia. by 24 in. long.

On the recent trial trip of the U. S. S. *Alabama*, over the Cape Ann course, an average speed of about 17 knots was maintained.